SCR INTEGRITY STUDY

PROBABILISTIC RELIABILITY AND INTEGRITY ASSESSMENT OF LARGE DIAMETER STEEL COMPLIANT RISERS FOR DEEPWATER

VOLUME 1 – MAIN STUDY REPORT

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1. EXECUTIVE SUMMARY

1.1 Background

For deepwater developments in the Gulf of Mexico, steel catenary risers (SCRs) supported from both SPAR and semi-submersible platforms have proven to be a successful solution for in-field flowlines, tie-backs and export systems. It is envisaged that this will continue to be the most economic solution as water depths increase further, up to and beyond 10,000 feet. However, it must be recognized that SCR engineering and analysis must also advance, in order to ensure that the systems developed for such water depths are technically sound, and safe, as well as economic.

The Minerals Management Service (MMS) commissioned INTEC and Martec to study the reliability and integrity of SCRs in "ultra-deepwater" (i.e, ~10,000 feet) in the Gulf of Mexico. At the time this report was prepared, there were no existing SCRs in 10,000 feet water depth – the deepest existing SCRs were in 6000 feet water depth (at BP Thunder Horse).

The study was performed in two distinct parts: Part 1 – deterministic analysis; and Part 2 – probabilistic analysis. These were further divided into the following activities:

Part 1 – Deterministic Analysis

1. Preparation and population of a worldwide SCR database.
2. Investigation of the importance of vessel-mooring system coupling in 10,000 feet water depth.
3. Technical review of the hang-off options available for SCRs supported from SPARs, and in particular the importance of hang-off elevation with respect to fatigue performance of SPAR supported SCRs in 10,000 feet water depth.
4. Comparison of an advanced SCR soil-pipe interaction model with conventional SCR seabed models.
5. Review of the importance of modeling touchdown point (TDP) mobility with respect to the calculation of VIV fatigue damage.

Part 2 – Probabilistic Analysis

6. Development of a probabilistic reliability-based framework for SCR assessment.

The SCR database was developed using Microsoft Access. The database has been populated with the key data for all known SCRs worldwide. For each SCR, information is provided regarding the location, dimensions, platform type, riser service, hang-off connection, installation method, strake coverage, cathodic protection strategy, etc. The electronic database has been submitted to the MMS separately. A copy of the User Manual is included in Appendix C. The database is not discussed further in this report.

This report (Volume 1) addresses activities 2 through 5 in detail. Volume 2, which is submitted together with this report, addresses activity 6.

The basis for all study activities is included in Appendix A of this report. In summary, the data is for a 10,000 feet water depth development in the Gulf of Mexico. The basic specification for SPAR and semi-submersible host vessel options are provided. The SCR considered in the analyses is a 16-inch outside diameter by 1-inch wall thickness oil and gas export SCRs.

1.2 Objective

The overall objective of the study is the continued development of an improved understanding of the reliability and integrity of large-diameter SCRs for ultra-deepwater applications.

1.3 Discussion of Main Study Activities

Global Motions Analysis

Basic design was performed for a SPAR and a semi-submersible and the associated mooring system to meet the requirements of the project design basis. It was confirmed that the mooring system satisfied strength and allowable offset criteria for the 100-year hurricane condition as defined in Table 3-4 of Appendix A.

Fully-coupled time domain analyses were performed for both platform types. Motions were developed for a full deepwater directional seastate scatter diagram (81 seastates in total). Extreme motions were calculated for the 100-year hurricane conditions. Additionally, fatigue seastate motions were calculated using a traditional uncoupled approach for comparison with the fully coupled motions. The purpose of this activity was to develop the motion data required for subsequent SCR analyses.

The fully-coupled analysis method includes the dynamic interaction between the platform and the mooring lines and risers, i.e., mass, damping and nonlinear stiffness. The tradition uncoupled approach does not include mass and damping – the mooring lines and risers are represented by a linearized stiffness based on the neutral configuration.

Fatigue (Coupled v. Uncoupled Motions)

Detailed fatigue calculations were performed for full seastate scatter diagram for the study case SCR and semi-submersible. This was completed for both the uncoupled and fully coupled vessel motions discussed above.

It was found that the fatigue life in the touchdown region was 50% longer for the fully-coupled motion case. However, at the hang-off location the fatigue life was found to be

14% longer for the uncoupled motion case. It is recommended that in 10,000 feet water depth, fully coupled motion analysis should be used for detailed engineering since the effect of riser and mooring system inertia and stiffness is significant.

SPAR SCR Hang-Off Strategy

Detailed fatigue analysis was performed for the full seastate scatter diagram for the study case SCR and SPAR platform. This was completed for two SCR hang-off locations – soft tank (i.e., near the keel of the SPAR) and bottom of the hard tank (below the mooring line fairleads).

It was found that the soft tank hang-off option resulted in a 50% longer fatigue life in the touchdown region than the hard tank hang-off option, although the surge standard deviation at the soft tank hang-off location is considerably larger due to the contribution from low frequency pitch-induced surge. This result demonstrates that it is important to assess SCR fatigue damage directly when selecting the hang-off location for a SPAR SCR.

With respect to the hang-off connection type for SPAR SCRs, there are three main options available. Two of these, flexible joint and tapered stress joint, require a subsea mechanical tie-in connection at the porch location. These options require diver-assisted tie-in, which can be particularly challenging for the soft tank hang-off option due to the greater water depth. The other option, a pull tube allows a continuous riser up to the topsides without mechanical connections. However, this latter option is considered to be more suitable for smaller diameter SCRs with relatively low bending stiffness due to the possibility of the riser getting caught-up in the pull tube. There are clear merits and demerits associated with each type of connection. All three are considered to be suitable solutions depending on the specific requirements of a project.

Touchdown Behavior – Seabed Model

Detailed time-domain analyses were performed using the advanced Carisima soil-pipe interaction model for selected fatigue and extreme conditions. Results were compared with equivalent results from a conventional soil-pipe model. At the time this report was prepared the majority of SCR design was performed using a conventional seabed model, as described in Section 7.3.2, and the Carisima module was not in general use. The Carisima model includes a sophisticated representation of the trenching behavior that is known to occur in the touchdown region of SCRs. As well as including the trench shape, the model includes suction effects that act to resist the SCR from being lifted up from the seabed and the walls of the trench which act to resist lateral movement.

There was a moderate to significant improvement in the fatigue life for the Carisima trench model cases. This tends to indicate that the conventional seabed model is conservative. However, since the Carisima model is relatively new, these results should be treated with some caution. It is recommended that the conventional model continue to be used pending further detailed investigation and calibration of the

Carisima model. In the long term, it is recognized that such advanced soil-pipe interaction models may be useful for obtaining a more accurate estimate of the fatigue in this critical region.

Seabed modeling was found not to be a significant consideration for extreme conditions because the maximum stresses occur higher up the riser in the sagbend region. For out-of-plane (or cross) environment directions the conventional model does tend to underestimate the stress in the touchdown region but this is not governing.

Touchdown Behavior – TDP Mobility in VIV Analysis

Single mode excitation was performed in the time-domain using a fully nonlinear SCR model. The resulting stress response in the touchdown point was compared with that from eigensolution modal analysis, which is the conventional approach to stress analysis for VIV calculations. Since the modal eigensolution requires linearization of the touchdown point behavior, essentially preventing the touchdown point from moving, it was anticipated that the stresses in this region may not be accurately calculated.

However, it was found that the modal analysis method does accurately calculate SCR stresses in the touchdown region for low frequency modes and small displacement amplitudes. This is the dominant condition for real SCRs since strakes are used to minimize the VIV response. As the response becomes larger, due to higher modes locking in or larger response amplitudes, the modal analysis method tends to overestimate the stress in this region. This would tend to lead to conservative fatigue life predictions.

One option to improve stress calculation accuracy in the touchdown region is the modal acceleration method. In summary, this approach would use the same VIV calculation procedure as is currently favored, but the TDP mobility would be accounted for by transforming the frequency domain VIV response back into the time domain and applying it to the full nonlinear SCR model. The benefit from such an enhancement to the VIV analysis procedures is considered to be marginal, however, since the inaccuracy in the touchdown point modeling for straked SCRs is probably not significant in comparison to the overall inaccuracy of VIV predictions.

1.4 Conclusions and Recommendations

Based on the work that is presented in this document the following conclusions and recommendations are identified:

1. Both the fatigue and extreme performance results for the study case SCR are good relative to typical project acceptance criteria. This tends to indicate that SCRs supported from appropriately designed SPARs and semi-submersibles are feasible in water depths up to and beyond 10,000 feet.

2. In general, the results of this study tend to indicate that conventional SCR analysis methods are conservative relative to more advanced methods. Although continued use of conventional methods will lead to safe and robust SCR design, there is some risk that in certain cases the use of conventional methods may indicate that SCRs are not feasible or lead to less economic solutions. In this case the more advanced methods could be appropriate.

3. In the case of vessel motion calculations, it is recommended that fully-coupled models be used for detailed engineering of deepwater SCRs to improve fatigue prediction accuracy.

4. Analysis using the advanced soil-pipe interaction model indicates that conventional design practice is conservative with respect to fatigue and appropriate for extreme conditions. Due to the preliminary nature of this type of seabed model, it is recommended that conventional seabed models continue to be used for detailed engineering of SCRs until more assessment and calibration is completed.

5. The modal analysis method used for VIV calculations is conservative. However, this conservatism is considered unlikely to be significant relative to the overall uncertainties in VIV prediction and fatigue calculations. Therefore, the benefits from a more advanced stress recovery solution may not be significant at this time.

2. INTRODUCTION

The consortium of INTEC Engineering Partnership Ltd. of Houston, Texas (referred to hereafter as INTEC) and Martec Limited, of Halifax, Nova Scotia (referred to hereafter as Martec) were awarded this project from the Minerals Management Service (MMS) in 2004. The project is being performed as part of the MMS Technology Assessment and Research (TA&R) Program Topic #8, which is concerned with assessment of the reliability and integrity of large diameter Steel Catenary Risers (SCR) for ultra-deepwater operations, including effects of fatigue, corrosion and wear associated with terminations at the platform or at touch down at the sea floor.

Offshore reservoirs are being developed in ever increasing water depths, semi-submersibles and SPARs with large diameter SCRs are considered to be the most economically viable development options. Through its involvement in various design projects and Joint Industry Projects (JIP), INTEC has gained considerable experience in the design of deepwater SCRs and in this position has been able to identify some of the key technical issues that need to be addressed to allow use of SCR technology in ever-increasing water depths. This project attempts to address a number of these issues including: the importance of using fully coupled platform motions for semi-submersible SCR design; hang-off strategy for SPAR SCRs; and, the soil-pipe interaction of SCRs in general. In addition, an electronic database of the worlds SCRs has been developed and populated.

The overall objective of the study is the continued development of an improved understanding of the reliability and integrity of large-diameter SCRs for ultra-deepwater applications.

3. DESIGN PREMISE

The data used in this study is documented in the project Design Basis, which is attached as Appendix A. The Design Basis includes background on relevant codes, standards and specifications, appropriate riser design criteria, fluid properties, flexible joint data, soil data, corrosion coatings, material properties, environmental data and host facility requirements. Data assumptions that are additional to the Design Basis are documented under the sections to which they apply.

4. GLOBAL MOTIONS ANALYSIS

4.1 Background

Global analysis was performed for generic steel catenary riser (SCR) floating production systems located in 10,000 feet water depth in the Gulf of Mexico, in order to provide motion data for SCR analyses.

Two alternative 33,000 kip (15,000 tonne) payload platforms were assessed: a truss SPAR and a semi-submersible. Both types of platform have been used extensively in the Gulf of Mexico. Semi-submersibles have been used in water depths of 6,000 feet and SPARs in water depths of 4500 feet. These types of platform are considered to be the most likely options for 10,000 feet plus water depths in the Gulf of Mexico in the near future. Tensioned Leg Platforms are considered to be a less likely solution in such water depths. Ship-shaped FPSOs are yet to be used in the Gulf of Mexico, and furthermore are unlikely to be compatible with SCRs due to this type of vessel's large pitch and roll motions.

Figure 4-1 shows an artist's impression of a large Gulf of Mexico semi-submersible. Figure 4-2 shows a computer visualization of a large Gulf of Mexico truss SPAR platform.

For both types of facility considered, vessel motions were calculated for fatigue sea states and extreme conditions, as required for subsequent riser analyses. In both cases, it was assumed that Platform North coincides with Grid North. The global (right-hand) axis system for motion analysis was selected such that x was aligned with East, and y with North.

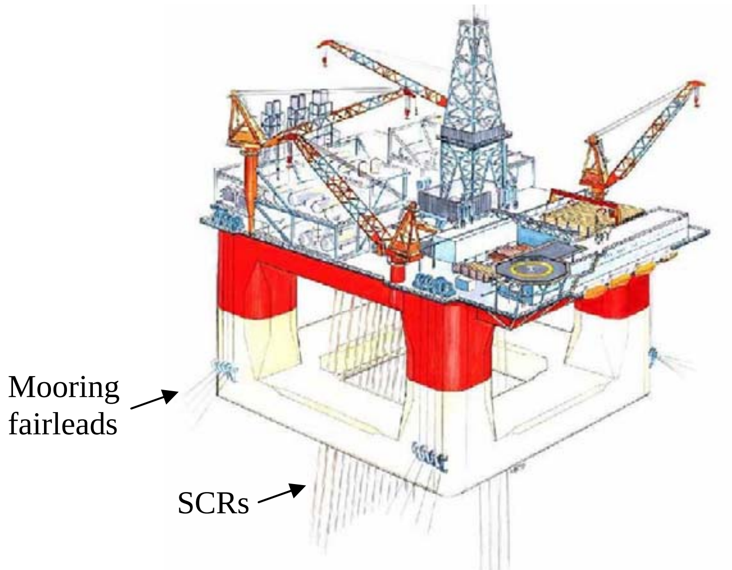

Figure 4-1: Semi-Submersible Platform (Artist's Impression of BP's Thunder Horse Semi-Submersible Platform)

Figure 4-2: SPAR Platform (Computer Visualization of BP's Holstein Truss SPAR Platform)

4.2 Methodology

The vessel motion analysis was performed using AQWA [Ref. 3]. AQWA is an integrated suite of analysis programs for analyzing floating offshore structures. It includes diffracting elements, Morison elements and disc elements for representing the hull (as a rigid body), and cable elements for modeling mooring lines and risers. AQWA can perform irregular sea dynamic analysis in the time-domain, including mooring line and riser dynamics and their interaction with the vessel (i.e., coupled analysis).

The hydrodynamic analysis consisted of the following steps:

1. A panel model of the hull was generated using ANSYS [Ref. 4] and then translated into AQWA format.

2. The AQWA-LINE input files, of the vessel hull, were compiled.

3. AQWA-LINE was used to calculate added mass, and wave damping, wave excitation and wave drift forces. Vessel motion response amplitude operators (RAOs) were also calculated.

4. The AQWA-DRIFT input files were prepared. Models of the mooring lines and SCRs were established. Current, wind and wave data were specified.

5. AQWA-DRIFT irregular wave time-domain analysis was performed.

6. The AQWA-DRIFT output was post-processed to generate motion time traces for subsequent riser analysis.

The SPAR hard and soft tanks, and the semi-submersible hull were modeled using panel elements to calculate diffraction forces and Morison elements (drag only) to include viscous damping. The SPAR heave plates were modeled using the drag and added mass disc elements. Morison elements were used to represent the spar truss members. The moorings and risers were modeled using cable elements, which also include Morison loading.

4.3 Load Cases

The following load cases were performed for both platform types:

- Decay test to calculate the system natural periods
- RAO calculations.
- Time-domain dynamic analysis for 100-yr hurricane conditions, for each of three headings: near, far and cross.
- Time domain dynamic analysis for 27 fatigue sea states, for each of three headings: near, far and cross.

Near, far and cross refer to the direction of the environment relative to the position of the riser. A near environment is in the plane of the riser and causes the platform to offset towards the riser such that the riser becomes less taut. A far environment is also in the plane of the riser but causes the platform to offset away from the riser such that the riser becomes tauter. A cross environment has a heading that is normal to the plane of the riser.

For the RAO calculations, analyses were performed for wave headings in 45 degree increments and for wave periods ranging from 4 to 50 seconds.

For the time-domain calculations, a time step of 0.25 seconds was used to ensure that the motion content for the full range of significant frequencies was accurately represented. A simulation time of 12,750 seconds was used – the first 1950 seconds were discarded to eliminate transient response. The remaining 10800 seconds (i.e., 3 hours) were processed for use in the riser analyses.

For the semi-submersible platform, the complete set of time-domain fatigue motion analyses were performed using both an uncoupled and a fully coupled model, to allow comparison of the predicted riser fatigue performance in each case. This is discussed in detail in Section 5. For the 100-year hurricane condition, the motions were calculated using the fully coupled model.

For the SPAR, all of the analyses were performed using a fully coupled model.

4.4 SPAR Analysis

4.4.1 Generic SPAR Design

A generic truss spar suitable for use in 10,000 feet water depth in the Gulf of Mexico was designed. The total displacement of the SPAR is 118,100 kip (53,550 tonnes) and the center-of-gravity is located at platform-center and 336.3 feet (102.5 meters) above the keel. The hull, mooring and riser data are summarized in Table 4-1.

The SPAR mooring lines are arranged in four groups, with 90-degree separation angle. There are four lines in each group with a separation angle of 5 degrees. A summary of the mooring line properties are presented in Table 4-2.

The spread mooring lines comprise 10692 feet (3259 meters) of 6-inch (154 mm) diameter rope, 249 feet (76 meters) of 7-inch (177.8 mm) diameter chain at the fairlead and 2001 feet (610 meters) of the same chain at the seabed – oil rig quality (ORQ). The initial mooring pretension in the neutral condition is 15% of the rope minimum breaking load (MBL).

The SCR hang-off locations are given in Table 4-3. The coordinate system is shown in Figure 4-3. The origin is located at the keel at the platform center with the z-coordinate upwards. Two alternative riser hang-off options were considered: soft tank and hard tank. This is discussed in detail in Section 6. In both cases the x and y coordinates of the hang-off locations are the same. There is a 9.8 feet (3 meter) separation between the hang-off points, and the riser headings differ by 5 degrees.

Table 4-1: SPAR Hull Data

Item	Value	Unit
Hull Geometry		
Displacement	118099 \ 53550	kip \ Te
Draft	500.3 \ 152.5	ft \ m
Hard tank diameter	115 \ 35	ft \ m
Hard tank height	233 \ 71	ft \ m
Free board	50.8 \ 15.5	ft \ m
Truss height	300.2 \ 91.5	ft \ m
Soft tank height	18.0 \ 5.5	ft \ m
Soft tank width/breadth	81.4 \ 24.8	ft \ m
Center-well width/breadth	49.2 \ 15	ft \ m
Truss Configuration		
Truss column diameter	8.2 \ 2.5	ft \ m
Number of heave plates	3	-
Heave plate OD	114.8 \ 35	ft \ m
Mooring Configuration		
Number of mooring line groups	4	-
Number of mooring lines	16	-
Fairlead hang-off elevation	318 \ 97	ft \ m (above keel)
Riser configuration		
Number of SCRs	2	-
SCR hang-off elevation (Option 1 – soft tank)	18.0 \ 5.5	ft \ m (above keel)
SCR hang-off elevation (Option 2 – hard tank)	318 \ 97	ft \ m (above keel)
Topside Weights		
Max. topside weight in extreme condition	30190 \ 13690	kip \ Te
Deck VCG in extreme condition (from keel)	617 \ 188	ft \ m
Max. topside weight in operating condition	30680 \ 13910	kip \ Te
Deck VCG in operation condition (from keel)	620 \ 189	ft \ m

Table 4-2: Mooring Line Properties

Item	Value	Units
Fairlead Chain (Studless)		
Chain Diameter	7 \ 177.8	in \ mm
Weight in air	426 \ 634	lbf/ft \ kgf/m
Weight in water	370 \ 551	lbf/ft \ kgf/m
EA	2.31E6 \ 1.03E7	kip \ kN
Breaking Strength (with 12 mm corrosion allowance)	5278 \ 23479	kip \ kN
Length	250 \ 76.2	ft \ m
Bottom Chain (Studless)		
Chain Diameter	7 \ 177.8	in \ mm
Weight in air	426 \ 634	lbf/ft \ kgf/m
Weight in water	370 \ 551	lbf/ft \ kgf/m
EA	2.31E6 \ 1.03E7	kip \ kN
Breaking Strength (with 12 mm corrosion allowance)	5278 \ 23479	kip \ kN
Length	2000 \ 609.6	ft \ m
Wire		
Wire Diameter	6.06 \ 154	in \ mm
Weight in air	84.9 \ 126.4	lbf/ft \ kgf/m
Weight in water	68.3 \ 101.7	lbf/ft \ kgf/m
EA	4.68E5 \ 2.08E6	kip \ kN
Breaking Strength (with 12 mm corrosion allowance)	5203 \ 23145	kip \ kN
Length	10692.8 \ 3259.2	ft \ m

Table 4-3: SCR Hang-Off Details

Hang-Off Option	X (ft \ m)	Y (ft \ m)	Z (ft \ m)	Azimuth Angle wrt X-axis (degree)
Option 1 – Soft Tank				
Gas riser	37.7 \ 11.5	59.0 \ 18.0	18.0 \ 5.5	50
Oil riser	47.6 \ 14.5	59.0 \ 18.0	18.0 \ 5.5	45
Option 2 – Hard Tank				
Gas riser	37.7 \ 11.5	59.0 \ 18.0	318.2 \ 97	50
Oil riser	47.6 \ 14.5	59.0 \ 18.0	318.2 \ 97	45

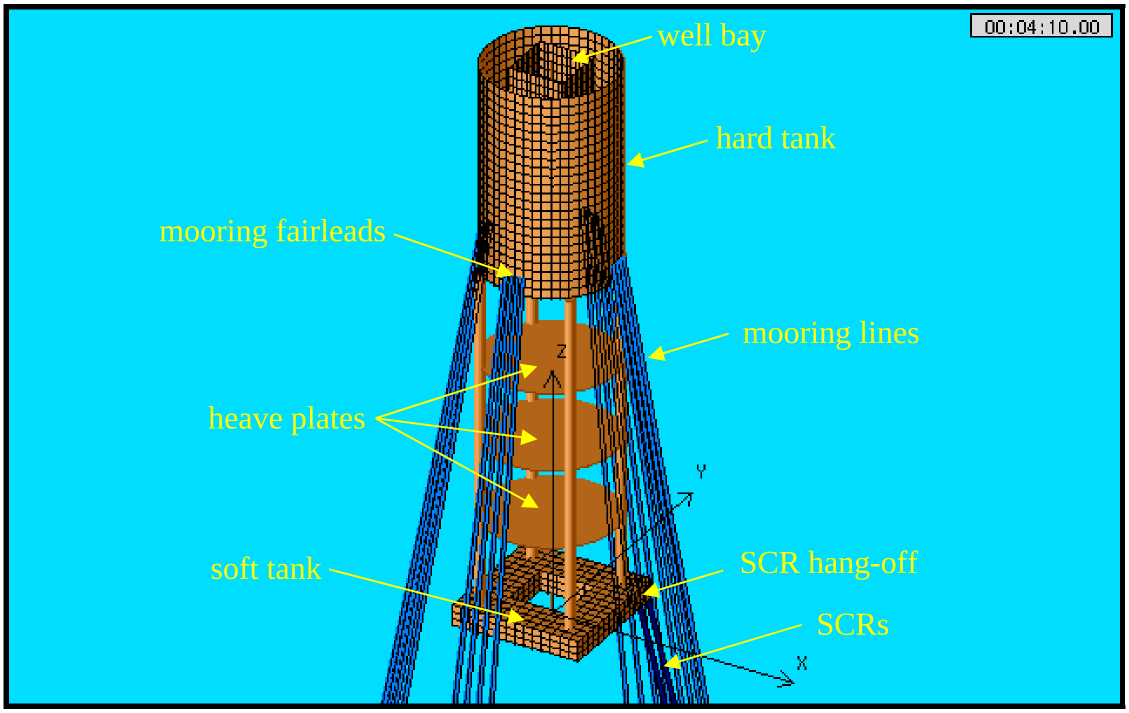

Figure 4-3: SPAR Model Isometric View and Coordinate System

4.4.2 Numerical Model

The complete coupled analysis model consists of:

- 764 panels for the soft and hard tanks combined (taking advantage of symmetry)
- 3 disks for the heave plates
- 2 Morison elements for hard and soft tank drag forces
- 4 Morison elements to represent the truss columns
- 16 mooring lines
- 2 SCRs

Figure 4-3 shows an isometric view of the computer model. The mooring fairleads are located at the center-of-gravity elevation. The SCRs are hung-off at the top the soft tank. Figure 4-4 and Figure 4-5 respectively show elevation and bottom views of the model.

The model only includes the two study case risers. For more accurate calculation of the platform motions for a real SPAR, the top-tensioned risers and any addition SCRs and umbilicals would also be included in the model.

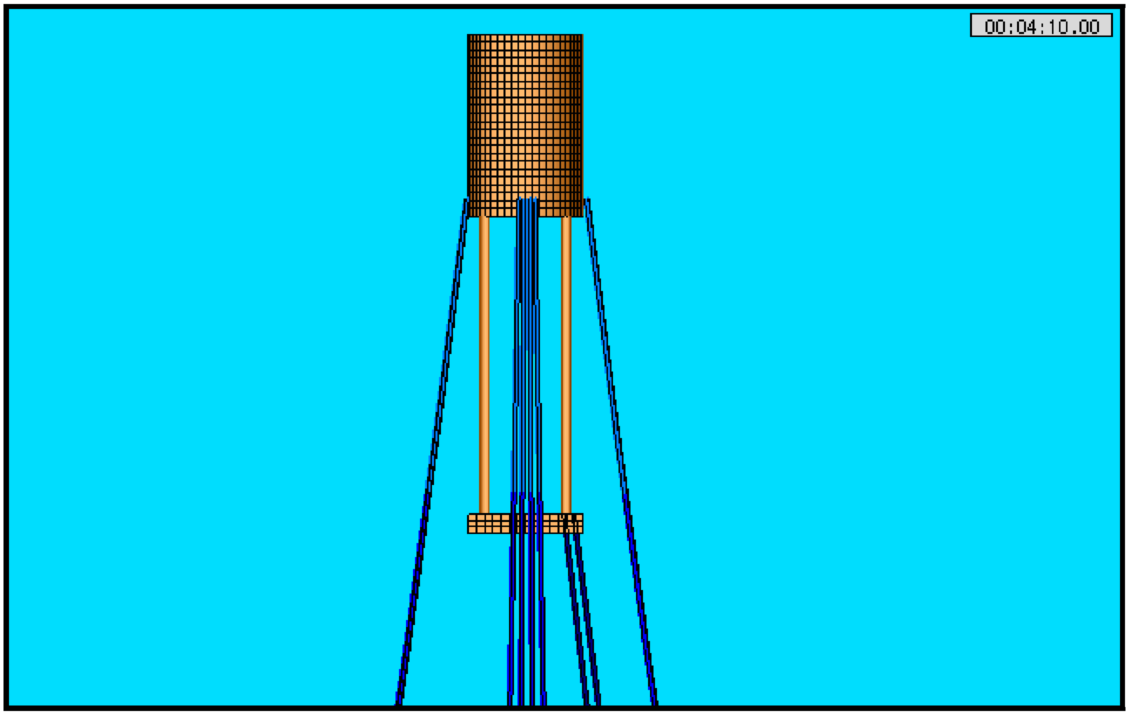

Figure 4-4: SPAR Model Elevation View

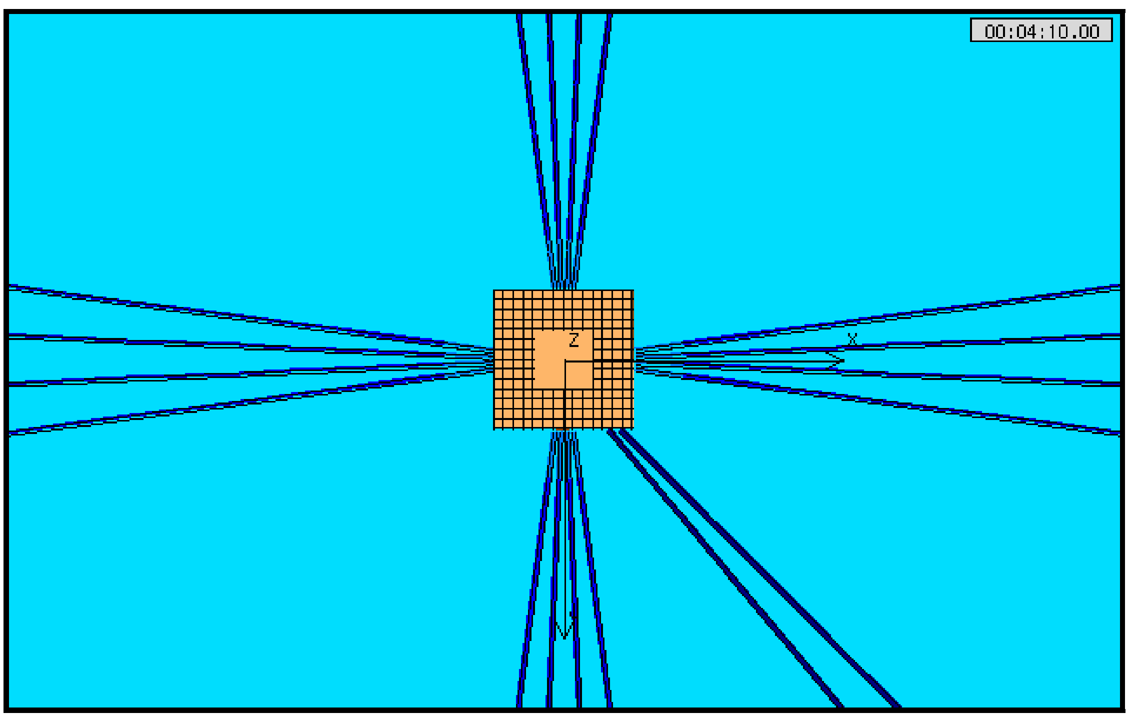

Figure 4-5: SPAR Model Bottom View

The hydrodynamic coefficients used in the analyses are summarized in Table 4-4.

Table 4-4: Hydrodynamic Coefficients for Morison Elements

Component	Drag Coefficient	Reference Area	Added Mass Coefficient	Reference Volume
Hard Tank	0.7	Hard tank outer area	NA	NA
Truss	1.05	Truss projected area	1.0	Truss volume
Heave Plate	1.14	Heave plate area	1.0	Sphere of heave plate diam.
Soft tank	0.7	Soft tank outer area	NA	NA

For the large diameter tanks, which are principally modeled using panel elements, the Morison elements provide an estimate of the hydrodynamic drag forces only. The added mass is calculated directly in the diffraction analysis.

The relatively small diameter truss members are modeled using Morison elements only, since diffraction effects are negligible. In this case both added mass and drag coefficients are required.

The heave plates are modeled using disc elements, for which the hydrodynamic load is also based on a Morison-type equation, requiring drag and added mass coefficients. The purpose of the heave plates is to provide a high level of drag damping to eliminate resonant heave motion. The heave plates are very effective and consequently SPARs have relatively small dynamic heave response.

The wind force and moment coefficients are given in Table 4-5. The wind loads are calculated as the product of the wind coefficient and the square of the wind speed. Moment is applied about the hull center-of-gravity.

Table 4-5: Wind Coefficients

Env. Heading (deg.)	C_{Fx} ($lbfs^2/ft^2$ \ Ns^2/m^2)	C_{Fy} ($lbfs^2/ft^2$ \ Ns^2/m^2)	C_{Mx} ($lbfs^2/ft$ \ Ns^2/m)	C_{My} ($lbfs^2/ft$ \ Ns^2/m)
0 (to positive x)	54.7 \ 2620	0	0	15529 \ 226630
45	38.6 \ 1850	38.6 \ 1850	-10965 \ -160025	10965 \ 160025
90 (to positive y)	0	54.7 \ 2620	-15529 \ -226630	0

4.4.3 Analysis Results

Free Decay

Free decay tests were performed to find the natural periods of the SPAR in all six degrees of freedom. The natural periods are provided in Table 4-6. The Spar has relatively long natural periods except in heave motion. The heave natural period is short, so that the SPAR may be exposed to direct excitation by wave forces for longer period waves. However, as discussed above, the heave plates act to effectively dampen the heave response.

Table 4-6: SPAR Response Natural Periods (seconds)

Surge	Sway	Heave	Roll	Pitch	Yaw
495	485	24	48	48	46

Motion Response Amplitude Operators (RAOs)

The motion RAOs were calculated for the free floating SPAR. The surge pitch and heave RAOs are presented in Figure 4-6 through Figure 4-8. The heave RAO is sharply peaked at its natural period of 24 seconds, since the RAO calculation does not include hydrodynamic drag on the three heave plates, since this is nonlinear.

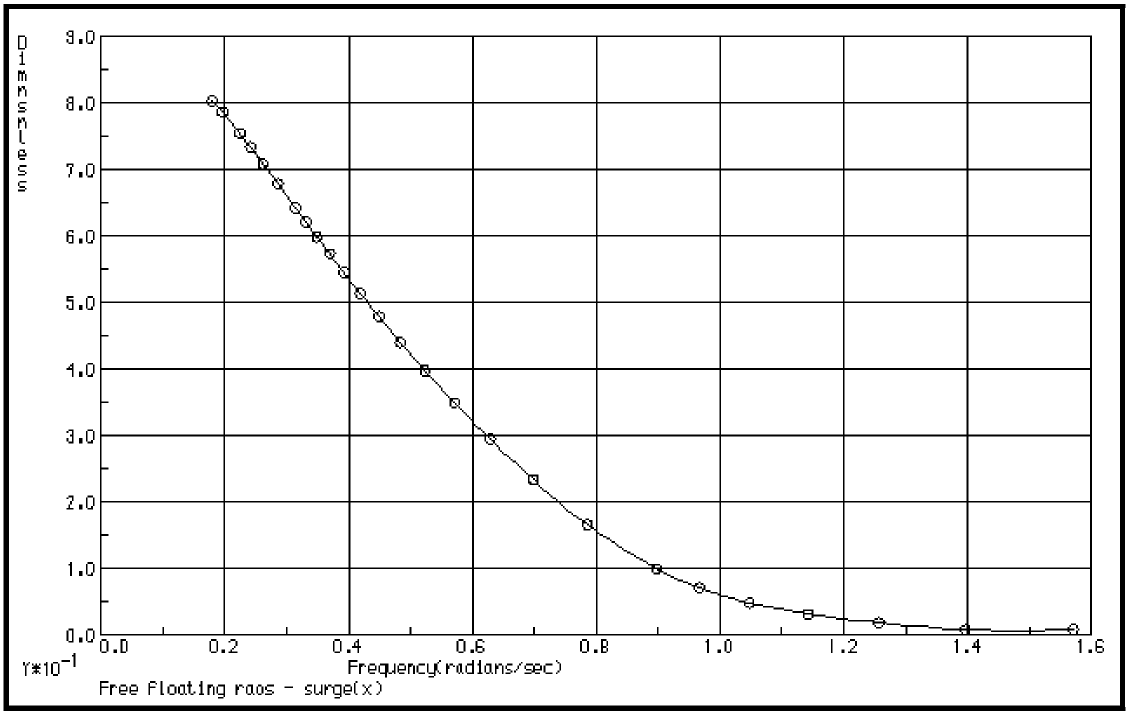

Figure 4-6: Free Floating Surge RAO – Wave Heading of 0 degrees

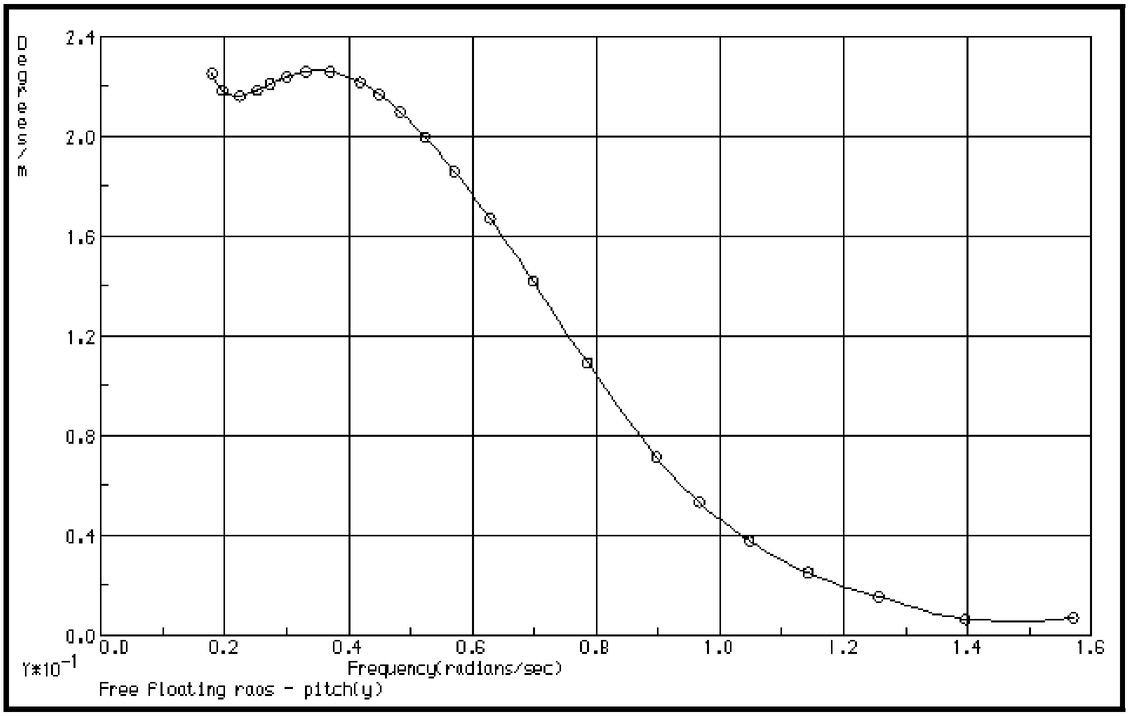

Figure 4-7: Free Floating Pitch RAO – Wave Heading of 0 degrees

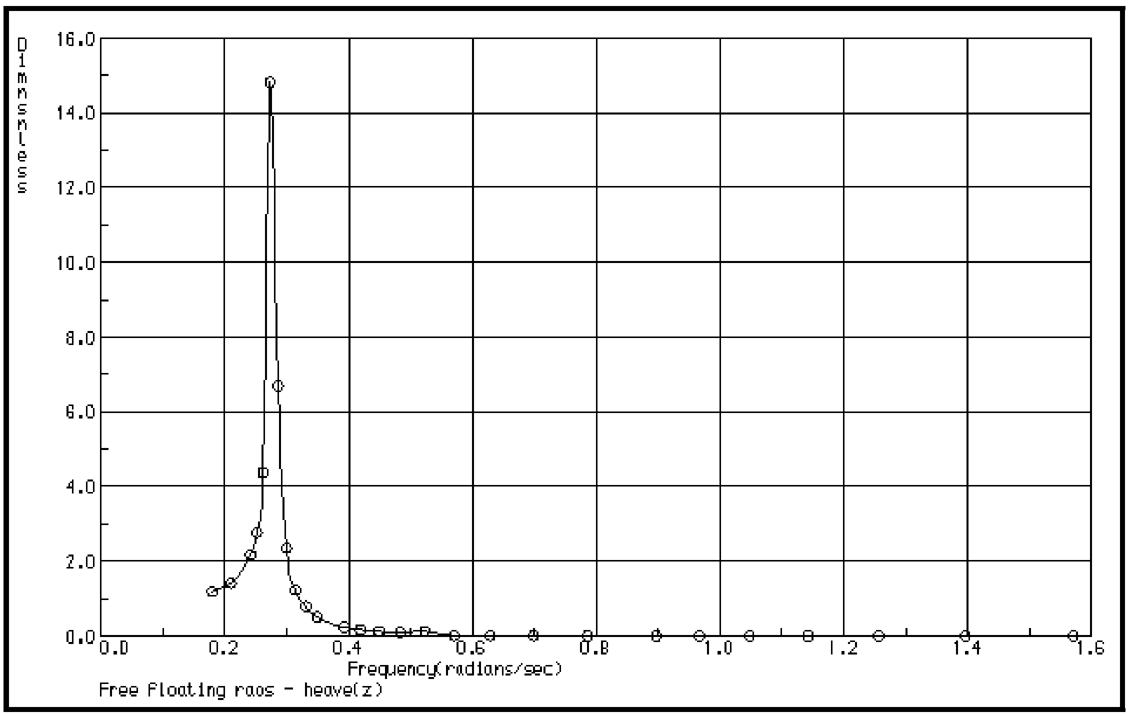

Figure 4-8: Free Floating Heave RAOs – Wave Heading of 0 degrees

Extreme Motions

Irregular wave extreme vessel motion analysis was performed for 100-yr hurricane conditions to confirm that the extreme offset is acceptable. The maximum offset was found to be 423 feet (129 meters), which is approximately 4.2% of water depth, and well within conventional design limits. This confirms that the mooring system is appropriately designed.

Table 4-7 presents mean, maximum and minimum SPAR surge and sway motions at the center-of-gravity, as well as roll and pitch angles.

Surge and sway motion time traces are shown in Figure 4-9. The mean offset is approximately 100 meters. Wave frequency motion is relatively small in comparison to the second order slow drift motion.

Figure 4-10 shows roll and pitch motion time traces. In this case, the wave frequency response is much larger than the second order response. The maximum pitch is approximately 6.8 degrees.

Table 4-7: Extreme Motion at CoG – 100-yr Hurricane

	Surge (ft \ m)	Sway (ft \ m)	Roll (deg.)	Pitch (deg.)
Mean	331 \ 101	-44.6 \ -13.6	-1.13	2.76
Max.	417 \ 127	0.00	0.10	6.77
Min.	-30.6 \ -9.33	-70.5 \ -21.5	-2.40	-1.69

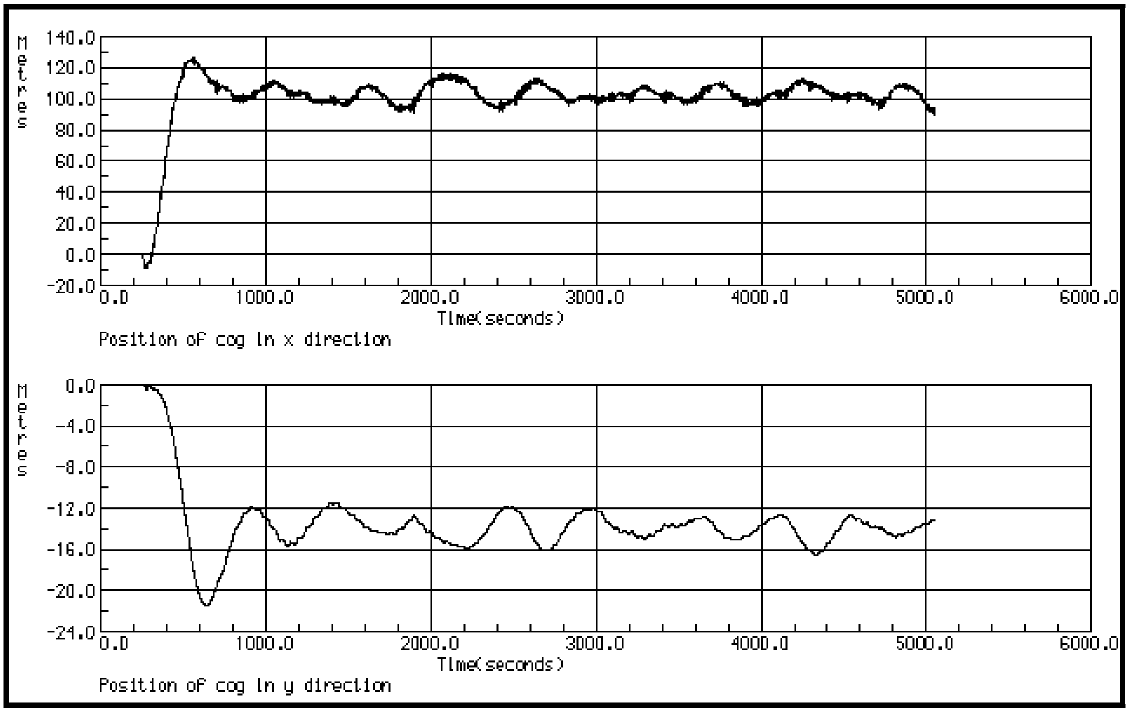

Figure 4-9: Surge and Sway Motion Time Traces

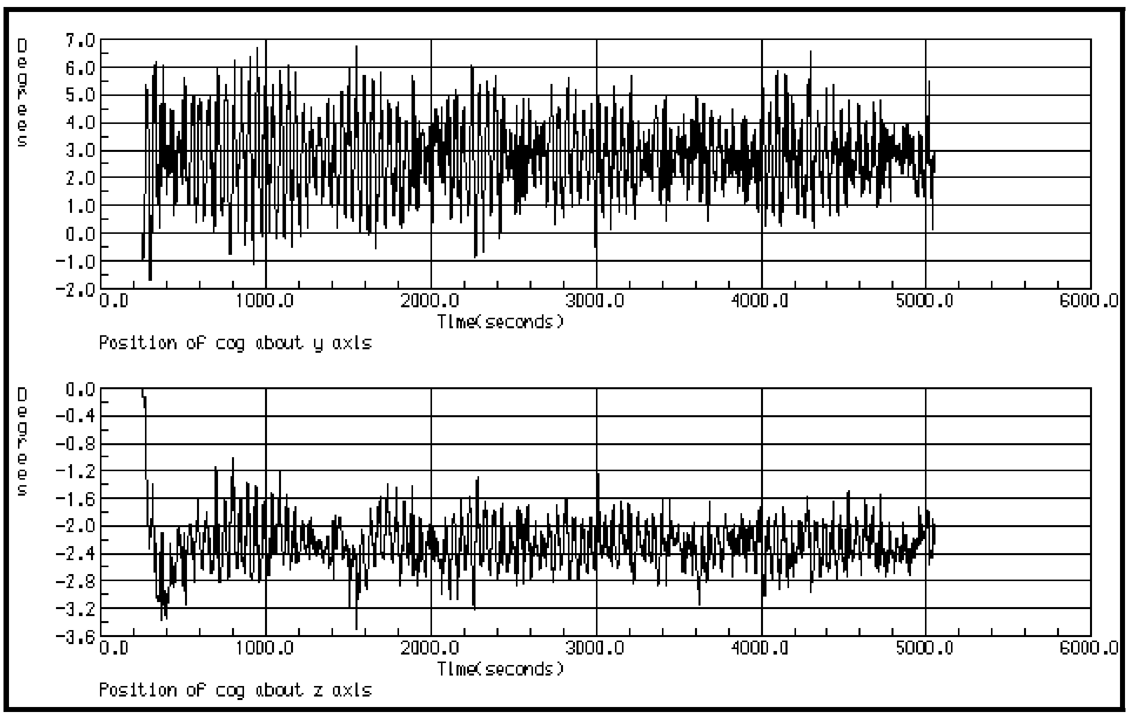

Figure 4-10: Pitch and Roll Motion Time Traces

Fatigue Motions

Irregular wave motion analysis was performed for the 27 fatigue sea states in near, cross and far directions. In all cases, the total offset is governed by the mean static offset. With respect to the dynamic motions, the slow drift is much larger in magnitude than the wave frequency motion. The cross offset is slightly larger than the near and far offsets due to the restoring forces from SCRs in the latter cases.

4.5 Semi-Submersible Analysis

4.5.1 Generic Semi-Submersible Design

A generic semi-submersible suitable for use in 10,000 feet water depth in the Gulf of Mexico was designed. The semi-submersible hull has four columns and a ring-pontoon. The operating draft is 110 feet (33.5 meters) and the displacement 99,000 kip (45,000 tonnes).

The hull, mooring and riser data are summarized in Table 4-8.

Table 4-8: Semi-Submersible Hull Data

Item	Value	Unit
Hull Geometry		
Displacement	98910 \ 44850	kip \ Te
Draft	109.9 \ 33.50	ft \ m
Hull height	165 \ 50.29	ft \ m
Hull width and breadth	247.7 \ 75.50	ft \ m
Column width and breadth	46.75 \ 14.25	ft \ m
Pontoon length	154.2 \ 47.00	ft \ m
Pontoon breadth	36.1 \ 11.00	ft \ m
Pontoon height	26.2 \ 8.00	ft \ m
GM (Meta-center height above center-of-gravity)	18.0 \ 5.50	ft \ m
KM (Meta-center height above keel)	97.3 \ 29.65	ft \ m
Mooring Configuration		
Number of mooring line groups	4	-
Number of mooring lines	12	-
Riser configuration		
Number of SCRs	2	-
SCR hang-off elevation	13.1 \ 4	ft \ m (above keel)
Topside Weights		
Max. topside weight in extreme condition	30190 \ 13690	kip \ Te
Deck VCG in extreme condition (from keel)	226.4 \ 69	ft \ m
Max. topside weight in operating condition	30680 \ 13910	kip \ Te
Deck VCG in operation condition (from keel)	229.7 \ 70	ft \ m

A semi-taut steel wire-chain system was adopted comprising top and bottom chain, wire in between, and anchors. The mooring lines are arranged in four groups, with a 90-degree separation angle. There are three lines in each group with a separation angle of 5 degrees. The mooring line properties are summarized in Table 4-9.

Table 4-9: Mooring Line Properties

Item	Value	Units
Fairlead Chain (Studless)		
Chain Diameter	4.7 \ 120	in \ mm
Weight in air	194 \ 288	lbf/ft \ kgf/m
Weight in water	169 \ 251	lbf/ft \ kgf/m
EA	1052 \ 4682	kip \ kN
Breaking Strength (with 12 mm corrosion allowance)	3456 \ 15376	kip \ kN
Length	223 \ 68	ft \ m
Bottom Chain (Studless)		
Chain Diameter	4.7 \ 120	in \ mm
Weight in air	194 \ 288	lbf/ft \ kgf/m
Weight in water	169 \ 251	lbf/ft \ kgf/m
EA	1052 \ 4682	kip \ kN
Breaking Strength (with 12 mm corrosion allowance)	3456 \ 15376	kip \ kN
Length	223 \ 68	ft \ m
Wire		
Wire Diameter	4.8 \ 122	in \ mm
Weight in air	53.7 \ 79.9	lbf/ft \ kgf/m
Weight in water	42.7 \ 63.6	lbf/ft \ kgf/m
EA	294 \ 1309	kip \ kN
Breaking Strength (with 12 mm corrosion allowance)	3327 \ 14800	kip \ kN
Length	23920 \ 7291	ft \ m

The riser hang-off locations are given in Table 4-10. The coordinate system is shown in Figure 4-11. The origin is located at the keel at the platform center with the z-coordinate upwards.

Table 4-10: SCR Hang-Off Details

Riser	X (ft \ m)	Y (ft \ m)	Z (ft \ m)	Azimuth Angle wrt X-axis (degree)
Gas	8.2 \ 2.5	118.4 \ 36.1	13.1 \ 4.0	87.5
Oil	-8.2 \ -2.5	118.4 \ 36.1	13.1 \ 4.0	92.5

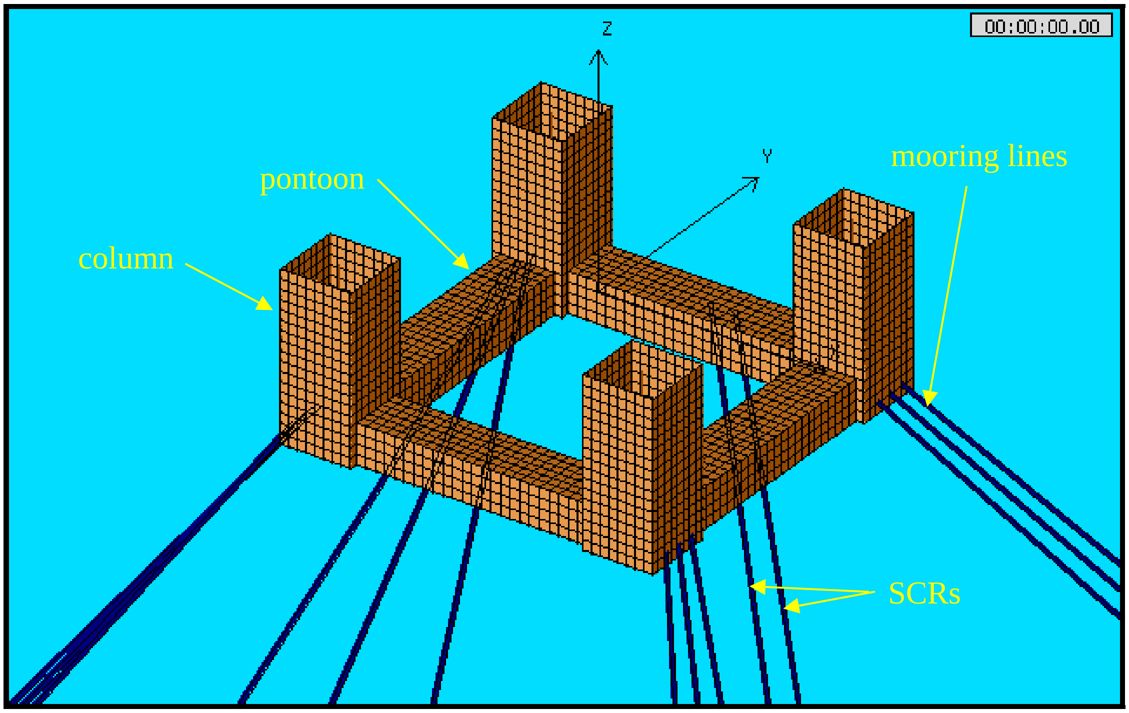

Figure 4-11: Semi-Submersible Model Isometric View and Coordinate System

4.5.2 Numerical Model

The complete coupled semi-submersible analysis model consists of:

- 1040 panels for the columns and pontoons (taking advantage of symmetry)
- 8 Morison elements for the columns and pontoons
- 12 mooring lines
- 2 SCRs

Figure 4-11 shows an isometric view of the computer model. The risers are seen to be supported from the North pontoon. As with the SPAR model, the semi-submersible model only includes the two study case risers. For more accurate calculation of the platform motions for a real semi-submersible, any in-field SCRs and umbilicals would also be included in the model.

For the columns and pontoons, which are principally modeled by panel elements, the Morison elements provide an estimate of the hydrodynamic drag forces only. Inertia effects are calculated directly in the diffraction analysis. A drag coefficient of 0.9 was assumed in both cases.

The wind force and moment coefficients are given in Table 4-11. The wind loads are calculated as the product of the wind coefficient and the square of the wind speed. Moment is applied about the hull center-of-gravity.

Table 4-11: Wind Coefficients

Env. Heading (deg.)	C_{Fx} ($lbfs^2/ft^2$ \ Ns^2/m^2)	C_{Fy} ($lbfs^2/ft^2$ \ Ns^2/m^2)	C_{Mx} ($lbfs^2/ft$ \ Ns^2/m)	C_{My} ($lbfs^2/ft$ \ Ns^2/m)
0 (to positive x)	75.6 \ 3620	0	0	11373 \ 165977
45	53.5 \ 2560	53.5 \ 2560	-8043 \ -117376	8043 \ 117376
90 (to positive y)	0	75.6 \ 3620	-11373 \ -165977	0

4.5.3 Analysis Results

Free Decay

Free decay tests were conducted to find the natural period of the semi-submersible in all six degrees of freedom. The results are presented in Table 4-12.

Table 4-12: Semi-Submersible Response Natural Periods (seconds)

Surge	Sway	Heave	Roll	Pitch	Yaw
294	240	20	25	21	42

Motion Response Amplitude Operators (RAOs)

The motion RAOs were calculated for the free floating semi-submersible and for the coupled system: semi-submersible, mooring lines and risers. The surge pitch and heave RAOs are presented in Figure 4-12 through Figure 4-14. The surge and heave motions are not affected by the risers and mooring system, however, the pitch response changes significantly.

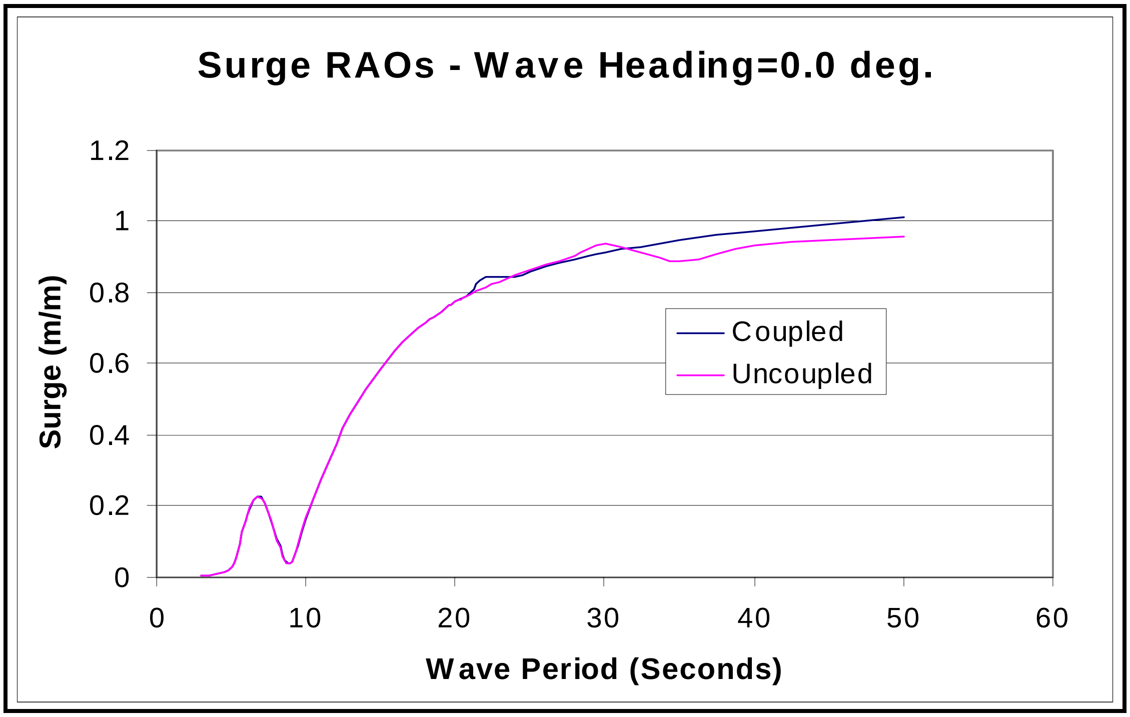

Figure 4-12: Surge RAO – Wave Heading of 0 degrees

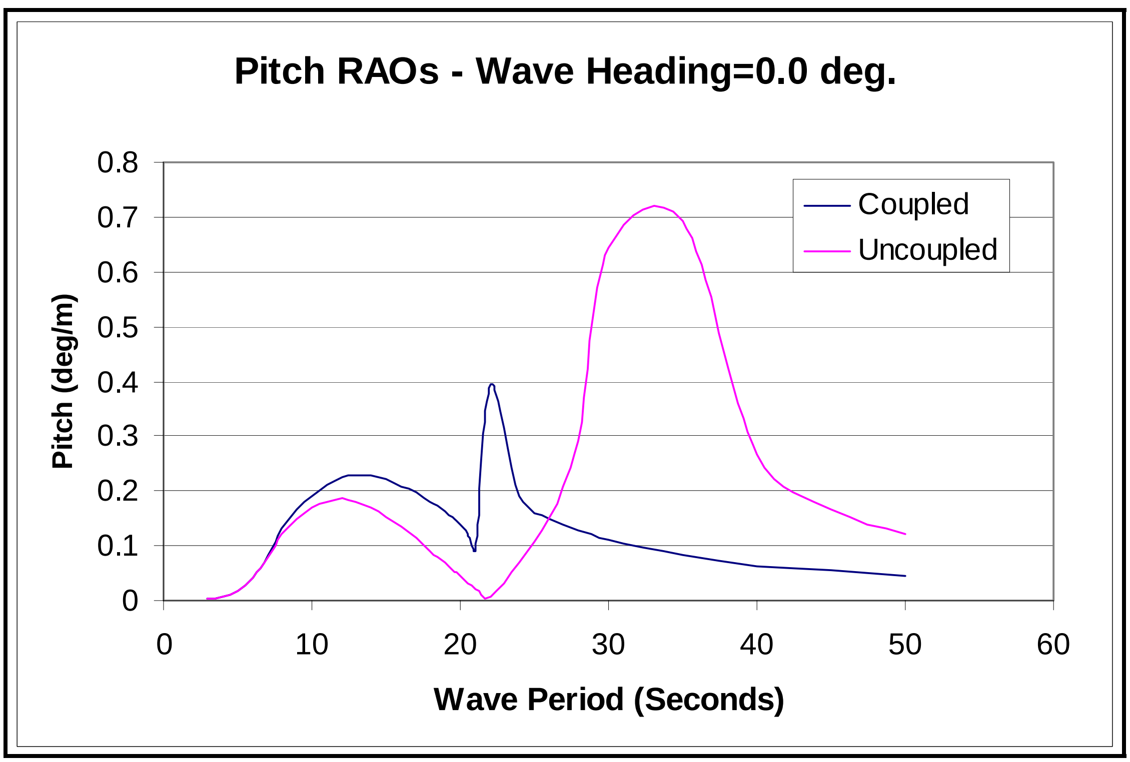

Figure 4-13: Pitch RAO – Wave Heading of 0 degrees

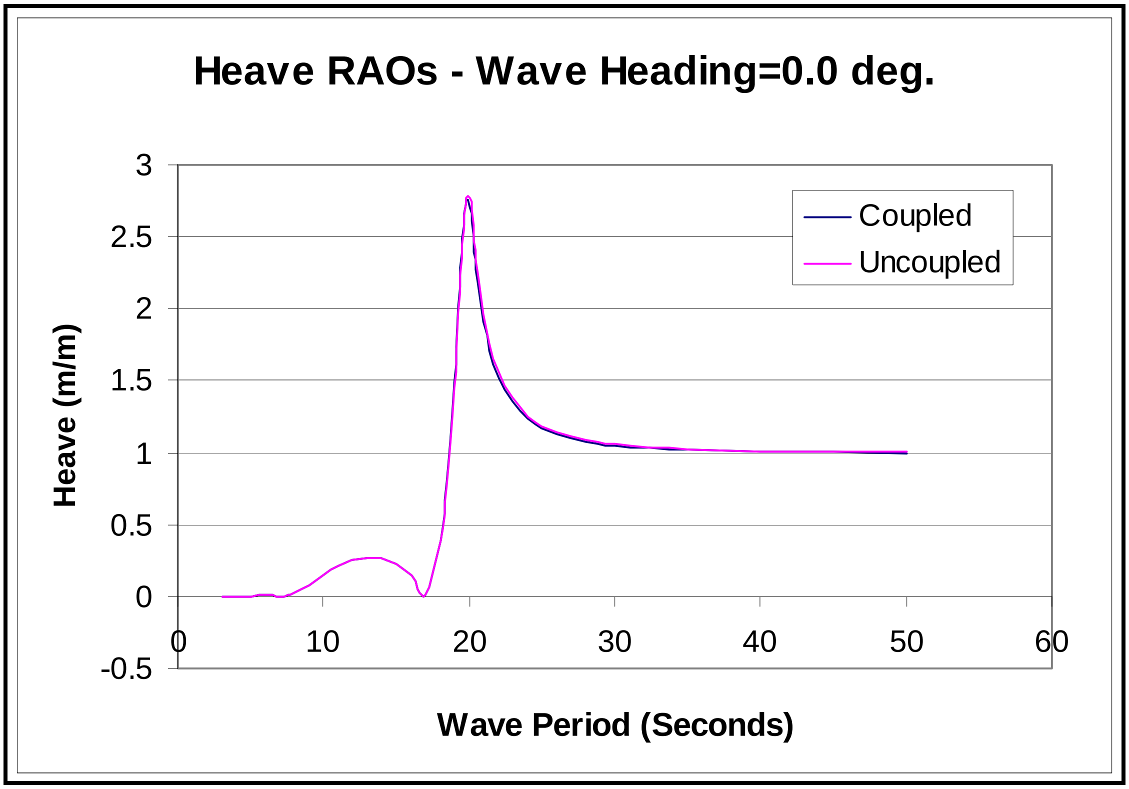

Figure 4-14: Heave RAO – Wave Heading of 0 degrees

Extreme Motions

Irregular wave extreme vessel motion analysis was performed for 100-yr hurricane conditions to confirm that the extreme offset is acceptable and to provide extreme event motions for the SCR touchdown behavior assessment. The maximum offset was found to be 614 feet (187 meters), which is approximately 6.1% of water depth, and within conventional design limits. This confirms that the mooring system is appropriately designed.

Fatigue Motions

Irregular wave motion analysis was performed for the 27 fatigue sea states in near, cross and far directions, with both coupled and uncoupled models. Figure 4-15 compares the sway motion for coupled and uncoupled models for a typical fatigue seastate: H_s = 6 feet (1.83 meters), T_p = 7 seconds. As can be seen, the slow drift motion amplitude is somewhat less for the coupled model.

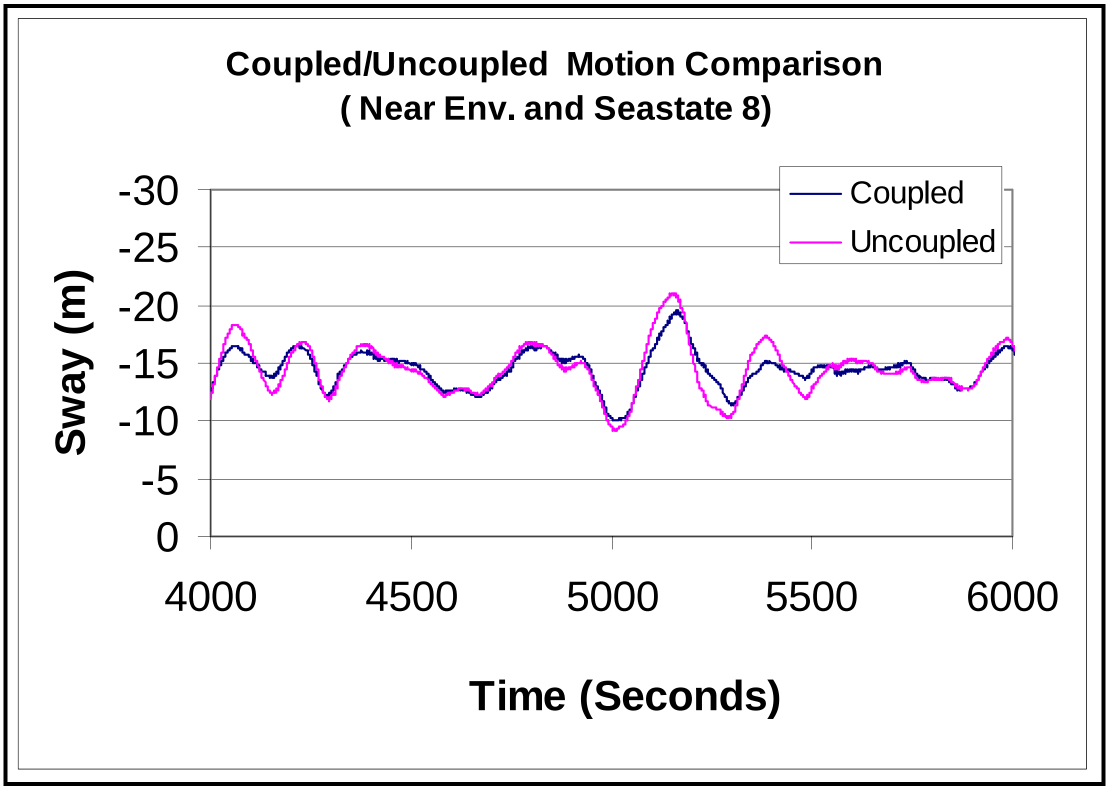

Figure 4-15: Semi-Submersible Sway Motion Time Trace

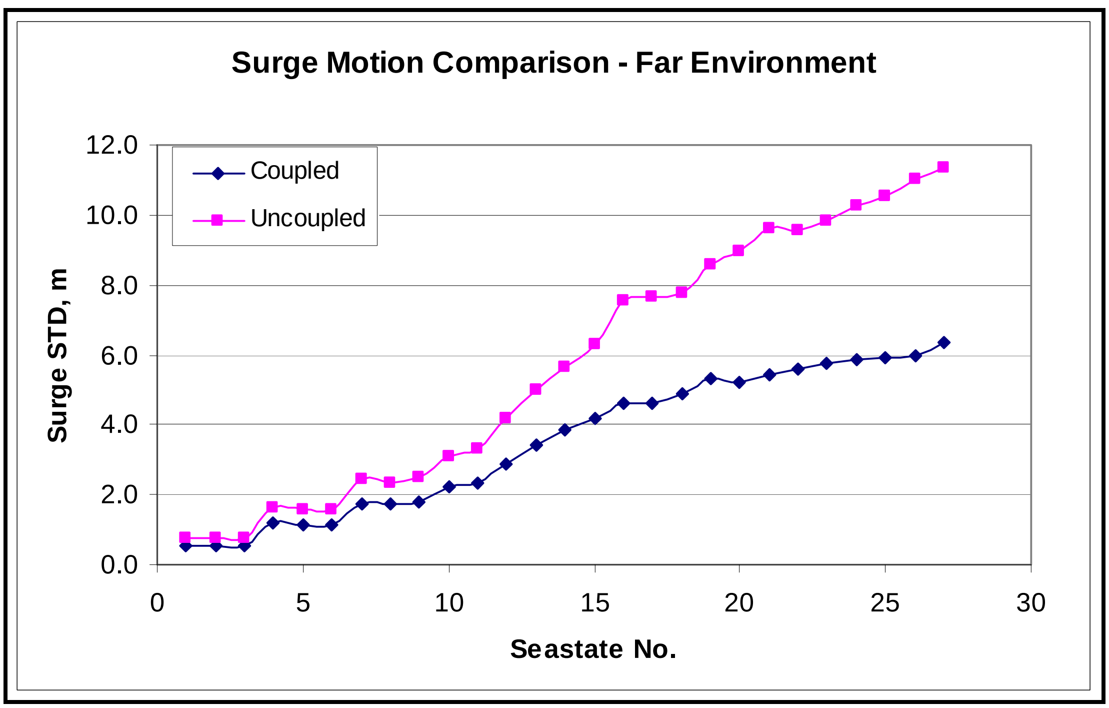

Figure 4-16: Semi-Submersible Surge Motion Timetrace

4.6 Conclusion

Fully-coupled time domain analysis was successfully completed for both semi-submersible and SPAR platform types. Additionally, uncoupled analyses were performed for the semi-submersible. In each case, 81 fatigue seastates were analyzed (27 in each of three directions, namely near, far and cross). Extreme motions, for 100-year hurricane conditions were also generate for the semi-submersible. This fulfils the motion requirements for all of the subsequent SCR analysis.

The coupled motion analysis shows that the mooring and riser restoring stiffness, mass and viscous damping will change wave frequency roll and pitch RAOs and slowly varying drift motion.

5. FATIGUE (COUPLED V. UNCOUPLED MOTIONS)

5.1 Background

Experience of deepwater SCR applications in the Gulf of Mexico has shown that fatigue is usually one of the most challenging design considerations. Wave loading fatigue contributes significantly to the total fatigue performance, through wave induced vessel motions. The SCR wave loading fatigue damage is related to the combined effect of various parameters, such as environmental conditions, fluid density, riser diameter, water depth, and host vessel motions.

In particular, SCR behavior is very sensitive to the motion characteristics of the host platform. In ultra-deepwater, the combined mass of the mooring lines, risers and umbilicals makes up a significant proportion of the system total mass. The hydrodynamic damping due to drag force on these slender bodies is also significant. Conventional "uncoupled" analysis does not directly take account of the contributions to inertial loads and damping from these components. A 'coupled analysis' does include these inertial and damping effects and solves them simultaneously with the vessel motion response.

The purpose of this activity is to evaluate semi-submersible motions for both 'fully coupled' and uncoupled models based upon the resulting SCR fatigue performance.

5.2 Methodology

Derivation of the semi-submersible motions using both coupled and uncoupled methods and a comparison of the results is presented and discussed in Section 4. Although the risers are included in the coupled platform motion model, the representation included therein does not include sufficient detail to be used for stress response. Therefore to calculate the riser fatigue life or extreme event performance, it is required to perform further analysis using specialist riser analysis software. This section primarily addresses the effect of the two sets of semi-submersible motions, i.e., coupled and uncoupled, on the riser fatigue response.

A Flexcom model of the SCR was established. Flexcom is a finite element program specifically developed for analyzing risers [Ref. 5]. The model includes all of the details of the SCR, as provided in Appendix A.

An initial static analysis is performed to determine the neutral configuration of the SCR. For each seastate in the seastate scatter diagram, the semi-submersible motions are applied to the top of the riser in a nonlinear time-domain analysis. The motions include mean offset, slow drift and wave frequency response.

A simulation time of three hours is used for each seastate, which is standard practice. For this particular case, three hours corresponds to approximately 40 slow drift cycles, which is judged to be sufficient to be statistically reliable.

A time step of 0.25 seconds is used to ensure that the highest frequency response is accurately captured. In addition to the vessel motions, the associated wave kinematics and current loading are applied.

5.3 SCR Numerical Model

The finite element mesh details for the study of the coupled versus uncoupled fatigue conditions are given in Table 5-1. Mesh refinement is made in the sag bend and touchdown region (element length of 1.6 feet) and close to the top connection as they are the locations with higher stresses in the pipe wall.

The boundary condition at the top of the riser is modeled using an articulation element, to represent a flexible joint connection. The stiffness data used are presented in Appendix A.

Strakes are included in the top 2000 feet (609.6 meters) of the SCR by applying a larger hydrodynamic diameter and increased drag and added mass coefficients, per Appendix A.

The three layer polyethylene (TLPE) abrasion resistant coating in the touchdown region is modeled by increasing the pipe hydrodynamic diameter and weight. The TLPE region extends for the first 6306 feet (1922 meters) from the anchor point. An FBE coating is then applied for a length of 7346 feet (2239 meters), up to a distance of 13,651 feet (4161 meters) along the SCR. The material densities of both type of coating are summarized in the design bases.

Table 5-1: Finite Element Mesh

Start Node	End Node	Number of Elements	Element Length (ft)	Segment Length (ft)	Distance Along Riser (ft)
1	53	52	49.3	2562.3	2562.3
53	63	10	32.8	328.1	2890.4
63	68	5	19.7	98.4	2988.8
68	73	5	13.1	65.6	3054.5
73	78	5	9.8	49.2	3103.7
78	86	8	6.6	52.5	3156.2
86	96	10	4.1	41.0	3197.2
96	111	15	3.3	49.2	3246.4
111	131	20	2.5	49.2	3295.6
131	291	160	1.6	262.5	3558.1
291	311	20	2.5	49.2	3607.3
311	326	15	3.3	49.2	3656.5
326	336	10	4.1	41.0	3697.5
336	344	8	6.6	52.5	3750.0
344	349	5	9.8	49.2	3799.2
349	354	5	13.1	65.6	3864.8
354	359	5	19.7	98.4	3963.3
359	364	5	26.2	131.2	4094.5
364	420	56	39.5	2212.3	6306.8
420	550	130	56.5	7345.7	13652.6
550	590	40	41.3	1652.6	15305.1
590	598	8	26.2	210.0	15515.1
598	603	5	13.1	65.6	15580.7
603	608	5	6.6	32.8	15613.5
608	613	5	3.3	16.4	15629.9
613	618	5	2.0	9.8	15639.8
618	629	11	1.2	12.8	15652.6
629	633	4	0.8	3.3	15655.8
633	636	3	0.7	2.0	15657.8

5.4 Fatigue Calculation

Each of the global analyses is post-processed to obtain time-histories of stress at critical locations along the riser. Fatigue damage is then obtained by performing rainflow cycle counting and SN damage accumulation calculations.

The damage rate determined for each seastate is weighted in accordance with that seastate's occurrence probability and the results are summed over all seastates to obtain the annual fatigue damage for each respective location.

The API RP-2A X' SN fatigue curve was used, as is common for SCR design. For this SN curve, the number of cycles to failure for a given stress range is obtained from $N = A*S^{-m}$, where A = 2.5E13 and m = 3.74 (where stress range is in MPa). The cumulative damage for a given stress range is given by the predicted number of cycles at that range divided by N. The predicted fatigue life is the inverse of the total fatigue damage, which is obtained as the sum of damage over all stress ranges following Palmgren-Miner.

5.5 Results

The SCR fatigue lives in the touch down region and at the hang-off are summarized in Table 5-2. The lives presented are unfactored i.e. no safety factor is applied. Typically a safety factor of 10 is required on the riser service life.

Table 5-2: Fatigue Life Summary

Motion Analysis Type	Touchdown Region	Hang-Off
Coupled	5037 years	3529 years
Uncoupled	3260 years	4028 years

The critical location is the hang-off. The fatigue life at the touchdown region is longer. The fatigue life in the touchdown region is plotted in Figure 5-1. Two well separated lows are observed, which are caused by the mean offsets associated with far and near environments. Since wave fatigue damage is primarily caused by in-plane vessel motions, there is no corresponding low at the neutral position.

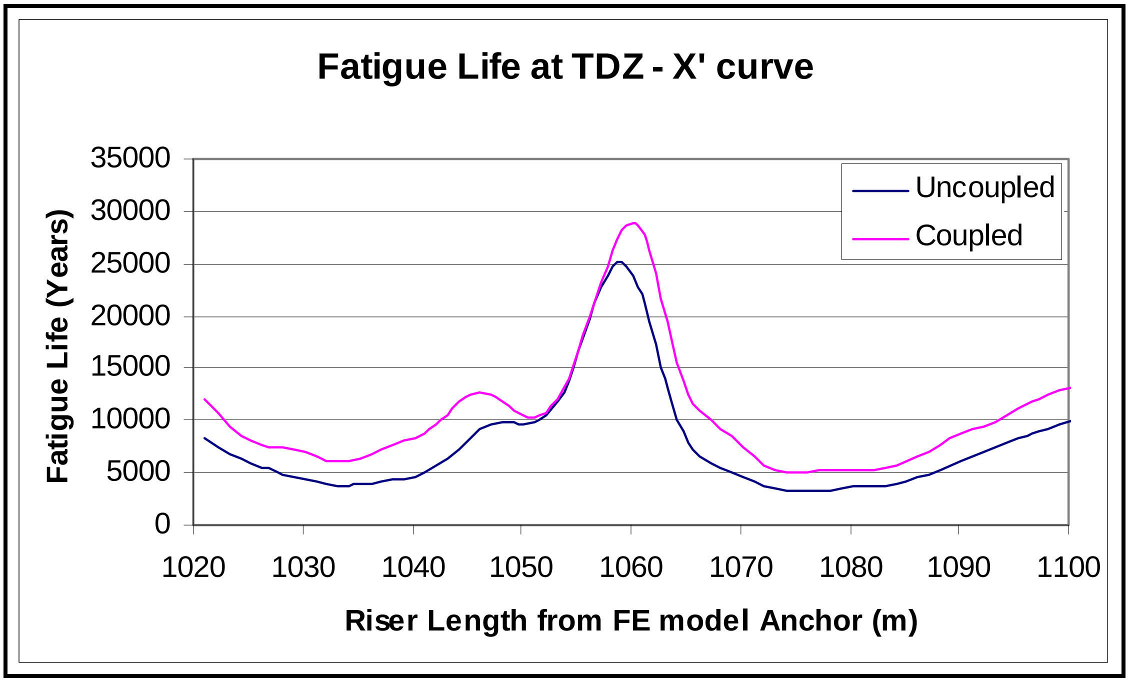

Figure 5-1: Fatigue Life in Touchdown Region

5.6 Conclusion

Fatigue analysis was performed for the study case semi-submersible SCR for the full seastate scatter diagram using both uncoupled and fully coupled vessel motions.

The analysis shows that the fatigue life in the touchdown region improves when a fully-coupled model is used to derive the motions but the fatigue life at the hang-off reduces. Although for the study example the fatigue lives are relatively long and so this may not be critical, the difference in terms of a percentage is large. Also since the uncoupled model does not always provide conservative results, it is recommended that fully coupled motion analysis be used for very deep water SCR fatigue design, since the contribution to the motions from the riser and mooring system inertia and stiffness is significant.

6. SPAR SCR HANG-OFF STRATEGY

6.1 Background

There are several different options for supporting an SCR from a SPAR platform. The SCR may be hung from the hard tank or the soft tank (see Figure 4-3) or pulled through a “pull tube” up to the topsides. If the SCR is supported by a porch structure on either the hard tank or soft tank, then the hang-off connection could be either a flexible joint or a tapered stress joint.

All of these options have been employed on SPAR facilities in the Gulf of Mexico and therefore it can be said that all options are feasible with respect to installation. However, it is of considerable interest to understand the benefits and costs of each type of solution.

The following sections consider: i) the effect that the hang-off location has on fatigue performance of the SCR; and, ii) the merits and demerits associated with the different types of hang-off connection (i.e., flexible joint, tapered stress joint or pull tube).

6.2 Hang-Off Location

In general, the selection of the hang-off location for an SCR is very important. It is desirable to keep the risk of a riser failure as low as practical, and in order to achieve this it is required to minimize the motions at the hang-off location. Usually this means placing the risers as close as possible to the platform center of rotation.

An interesting aspect of SPAR motion behavior is that the center of rotation for wave frequency response is located much lower on the hull than the center of rotation for low frequency or second order response. At low frequency, the SPAR pitches around the center-of-gravity, whereas at wave frequency the SPAR pitches around the keel (or slightly above the keel).

The second order pitch motion is much larger than the wave frequency pitch. Therefore a basic review of the pitch-induced surge would suggest that the optimum location to support the SCRs would be on the hard tank close to the center-of-gravity, i.e., where the total surge standard deviation is least.

However, since the second order pitch is of relatively long period (i.e., 48 seconds, see Table 4-6), it will not necessarily cause dynamic excitation of the SCRs. This is because the SCR’s low modes are relatively widely spaced in terms of period, so a resonance condition may not exist. On the other hand, the deepwater SCRs have many closely spaced modes within the range of wave frequencies. Therefore, there is always some degree of resonant excitation of the SCRs caused by the wave frequency motions. Furthermore, because of the long period of the second order pitch, there are relatively fewer cycles in comparison to the wave frequency response.

Therefore, for a SPAR the optimum location for hanging the riser is not immediately apparent. The objective of this activity is to determine for the best location for hanging of the SCR. Of course, as well as the riser dynamic performance, there are practical considerations including installation and platform layout.

6.2.1 Methodology

Derivation of the SPAR motions is presented and discussed in Section 4. For the purpose of this activity, two SCR models were established in Flexcom. In one case, the SCR was supported from the bottom of the hard tank. In the other case, the SCR was supported from the bottom of the soft tank, i.e., just above the keel. The hang-off locations are defined in more detail in Table 4-3. The models include all of the details of the SCR, as provided in Appendix A.

In each case, an initial static analysis is performed to determine the neutral configuration of the SCR. For each seastate in the seastate scatter diagram, the SPAR motions at the appropriate hang-off location are applied to the top of the riser in a nonlinear time-domain analysis. The motions include mean offset, slow drift and wave frequency response.

For each seastate, a simulation time of three hours and a time step of 0.25 seconds are used.

6.2.2 Numerical Model

Different finite element meshes were used for each hang-off case due to the different length of the risers. However, in both cases the meshes are refined in the sag bend and touchdown region (element length of 1.6 feet) and close to the top connection, as these are the locations with higher stresses. The mesh details are given in Table 6-1 and Table 6-2 for the hard tank and soft tank hang-off cases respectively.

For both hang-off locations, a flexible joint connection was assumed, using the stiffness data provided in Appendix A.

Table 6-1: Finite Element Mesh – Hard Tank Hang-Off

Start Node	End Node	Number of Elements	Element Length (ft)	Segment Length (ft)	Distance Along Riser (ft)
1	45	44	50.6	2226.0	2226.0
45	55	10	32.8	328.1	2554.1
55	60	5	19.7	98.4	2652.6
60	65	5	13.1	65.6	2718.2
65	70	5	9.8	49.2	2767.4
70	78	8	6.6	52.5	2819.9
78	88	10	4.1	41.0	2860.9
88	103	15	3.3	49.2	2910.1
103	123	20	2.5	49.2	2959.3
123	283	160	1.6	262.5	3221.8
283	303	20	2.5	49.2	3271.0
303	318	15	3.3	49.2	3320.2
318	328	10	4.1	41.0	3361.2
328	336	8	6.6	52.5	3413.7
336	341	5	9.8	49.2	3462.9
341	346	5	13.1	65.6	3528.5
346	351	5	19.7	98.4	3627.0
351	356	5	26.2	131.2	3758.2
356	420	64	40.7	2606.0	6364.3
420	550	130	52.8	6870.0	13234.3
550	590	40	41.3	1652.6	14886.8
590	598	8	26.2	210.0	15096.8
598	603	5	13.1	65.6	15162.4
603	608	5	6.6	32.8	15195.2
608	613	5	3.3	16.4	15211.6
613	618	5	2.0	9.8	15221.5
618	629	11	1.2	12.8	15234.3
629	633	4	0.8	3.3	15237.5
633	636	3	0.7	2.0	15239.5

Table 6-2: Finite Element Mesh – Soft Tank Hang-Off

Start Node	End Node	Number of Elements	Element Length (ft)	Segment Length (ft)	Distance Along Riser (ft)
1	53	52	50.4	2619.8	2619.8
53	63	10	32.8	328.1	2947.8
63	68	5	19.7	98.4	3046.3
68	73	5	13.1	65.6	3111.9
73	78	5	9.8	49.2	3161.1
78	86	8	6.6	52.5	3213.6
86	96	10	4.1	41.0	3254.6
96	111	15	3.3	49.2	3303.8
111	131	20	2.5	49.2	3353.0
131	291	160	1.6	262.5	3615.5
291	311	20	2.5	49.2	3664.7
311	326	15	3.3	49.2	3713.9
326	336	10	4.1	41.0	3754.9
336	344	8	6.6	52.5	3807.4
344	349	5	9.8	49.2	3856.6
349	354	5	13.1	65.6	3922.2
354	359	5	19.7	98.4	4020.7
359	364	5	26.2	131.2	4151.9
364	420	56	39.5	2212.3	6364.3
420	550	130	52.8	6870.0	13234.3
550	590	40	41.3	1652.6	14886.8
590	598	8	26.2	210.0	15096.8
598	603	5	13.1	65.6	15162.4
603	608	5	6.6	32.8	15195.2
608	613	5	3.3	16.4	15211.6
613	618	5	2.0	9.8	15221.5
618	629	11	1.2	12.8	15234.3
629	633	4	0.8	3.3	15237.5
633	636	3	0.7	2.0	15239.5

6.2.3 Results

The fatigue life results are presented in Table 6-3. As seen from these results, the fatigue life of a SPAR supported SCR is significantly affected by hang-off location. By moving the SCR hang-off location down to soft tank, the fatigue life is improved.

Figure 6-1 shows the fatigue life along the riser in the touchdown region for the two hang-off cases. It is seen that the improvement fatigue life occurs not only at the governing fatigue location but more generally along the riser. Therefore, it is clear in this case that the soft tank is a better hang-off location with respect to riser dynamic performance.

Table 6-3: Fatigue Life Summary

Hang-Off Location	Touchdown Region	Hang-Off
Hard Tank	32900 years	3420 years
Soft Tank	48300 years	4760 years

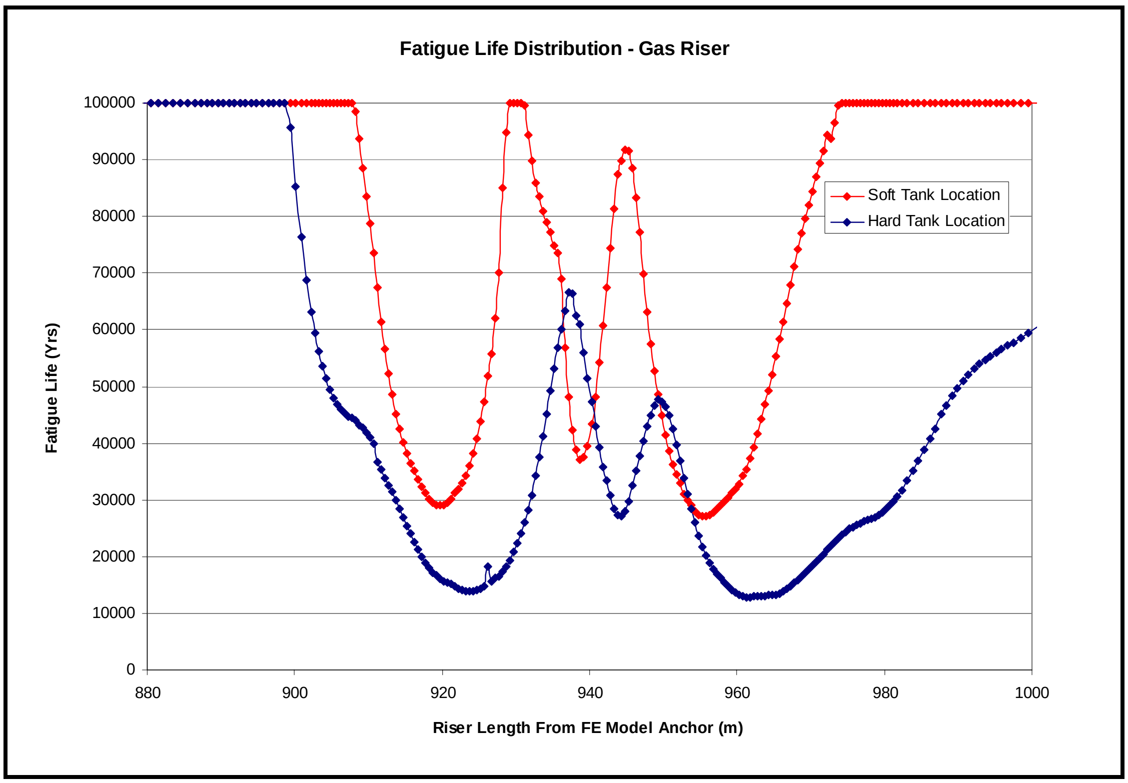

Figure 6-1: Fatigue Life in Touchdown Region

6.3 Hang-Off Connection

There are three general options for connecting SCRs to SPARs, which are flexible joint, tapered stress joint and pull tube. Of these, the flexible joint option is the most common and has been assumed throughout all of the analysis cases in this study, although all three types of connections have been used. They are discussed in turn below.

6.3.1 Flexible Joint

The flexible joint solution has been used on a large proportion of all of the SCRs in the Gulf of Mexico. The key benefit of a flexible joint is that it decouples the riser from the platform pitch and roll motions, thereby reducing the stresses in the upper region of the riser and in the supporting porch structure.

A flexible joint is a relatively sophisticated component in an otherwise mechanically simple SCR system. In order to accommodate the large relative rotations between the platform and the riser, it employs a large composite spherical elastomeric-steel element. To ensure that the elastomers are appropriately designed, it is important to accurately quantify the load conditions. In particular, if not accounted for in the design, high temperature and pressure fluctuations can lead to degradation of the elastomer and eventually a loss of containment integrity if not identified early.

It is important to note that degradation of the rubber can be observed long before there is any risk of leakage. Therefore, this issue can be managed by employing appropriate inspection procedures and being prepared to replace the flexible joint if necessary. Furthermore, the flexible joint will still maintain structural integrity even after complete failure of the elastomeric element.

A flexible joint connection is considered to be a reliable technical solution particularly if fatigue design at the top region of the riser is likely to be a challenge. Since they have been used extensively and over a long period of time, flexible joints can be considered to be mature technology.

6.3.2 Tapered Stress Joint

Tapered stress joints are also suitable in cases where the relative rotation between the platform and the riser is not excessive. Since SPAR pitch motions are relatively small, the tapered stress joint is a possible solution in many cases. However, as the riser size increases or the platform pitch and roll motions become more severe, the tapered stress joint design becomes more challenging. Furthermore, the riser support structure must also be increased to support the higher loads. Titanium can be used as an alternative to steel to increase the capabilities of the stress joint.

One benefit of a tapered stress joint is that it is a one-piece metallic component without any moving parts. It is therefore somewhat less complicated than a flexible joint. A tapered stress joint is also considered to be a good technical solution.

6.3.3 Pull Tube

The pull tube alternative is very attractive since it avoids the use of any subsea mechanical connections on the riser. The riser is drawn through the pull tube from the bottom of the SPAR all the way up to the topsides.

One concern with a pull tube is the potential for wear between the riser and the end of the pull tube, as the riser moves around. Good inspection procedures should ensure that such an issue is identified early. However replacement of a pull-tube SCR is considerably more complicated than for a porch supported SCR since the riser must be raised and lowered through the pull-tube, which may not be possible with the topsides in place.

With larger diameter risers, there is increasing risk of the riser getting stuck in the pull tube due to the high bending stiffness. Since the loads are larger, there is more risk of damage to the riser and the structure. Similarly, a pull tube option may not be practical for a J-lay riser due to the presence of the large J-lay collars.

6.4 Conclusion

Fatigue analysis was performed for the study case SPAR SCR for the full seastate scatter diagram for two hang-off locations – soft tank and hard tank. It was found that in this case the soft tank hang-off option provides better fatigue performance than the hard tank hang-off option, although the motion at the soft tank is larger due to the contribution from low frequency pitch-induced surge. This demonstrates that it is necessary to consider the fatigue damage directly when selecting the optimal hang-off location for a SPAR SCR, rather than considering only the total surge motion along the length of the SPAR.

With respect to the hang-off connection type for SPAR SCRs, it is found that there are a number of suitable connection types available, all of which have been employed in the past. There are benefits and costs associated with each type of connection and therefore it is recommended that all options be considered and addressed in the context of the specific application.

7. TOUCHDOWN BEHAVIOR – SEABED MODEL

7.1 Background

The region where the riser touches down on the seabed is typically found to be the governing fatigue location on an SCR. In fact, the fatigue damage predicted in this region is often orders of magnitude greater than the fatigue damage elsewhere on the riser. Furthermore, in some cases the fatigue in the touchdown region can be marginal with respect to fatigue design criteria, and may be critical with respect to the feasibility of an SCR solution. Therefore, it is of significant importance to be able to accurately predict fatigue damage in this region.

Typically, a flat and level area of seabed will be selected for the touchdown region of an SCR. However, camera footage recorded by remotely operated vehicles (ROVs) has shown that the development of a trench in the touchdown region is a common phenomenon. It is to be expected that the response of the riser may change somewhat as the seabed profile changes from a flat surface to a more compliant trench shape. As well as the change in seabed profile, additional effects may include so-called “suction” when the soil surrounding the riser acts to prevent the riser from being lifted, and also resistance to lateral movement of the riser due to the walls of the trench.

The changing behavior of the soil and the interaction with the riser is inherently complicated and is not well understood. Consequently, it is conventional to represent the seabed with a somewhat simplistic model, which does not include many aspects of the real physical behavior discussed above.

The “conventional” model is a flat contact surface with linear elastic contact stiffness in the vertical direction for positive penetration and zero stiffness for negative penetration. This model is robust and well understood, and is included in most (in fact probably all) of the software packages that are used to model SCRs. Using this type of model, it is known that fatigue damage increases with seabed stiffness, until a plateau is reached. Once the plateau is reached, it can be said that the seabed model is essentially approaching rigidity relative to the weight of the SCR that it supports. This is shown in Figure 7-1 which plots peak curvature versus seabed elasticity. The seabed elasticity is depth of penetration into the seabed (d), under self weight only, divided by the diameter of the pipe (D). Clearly, as this tends to zero, the seabed is approaching rigidity.

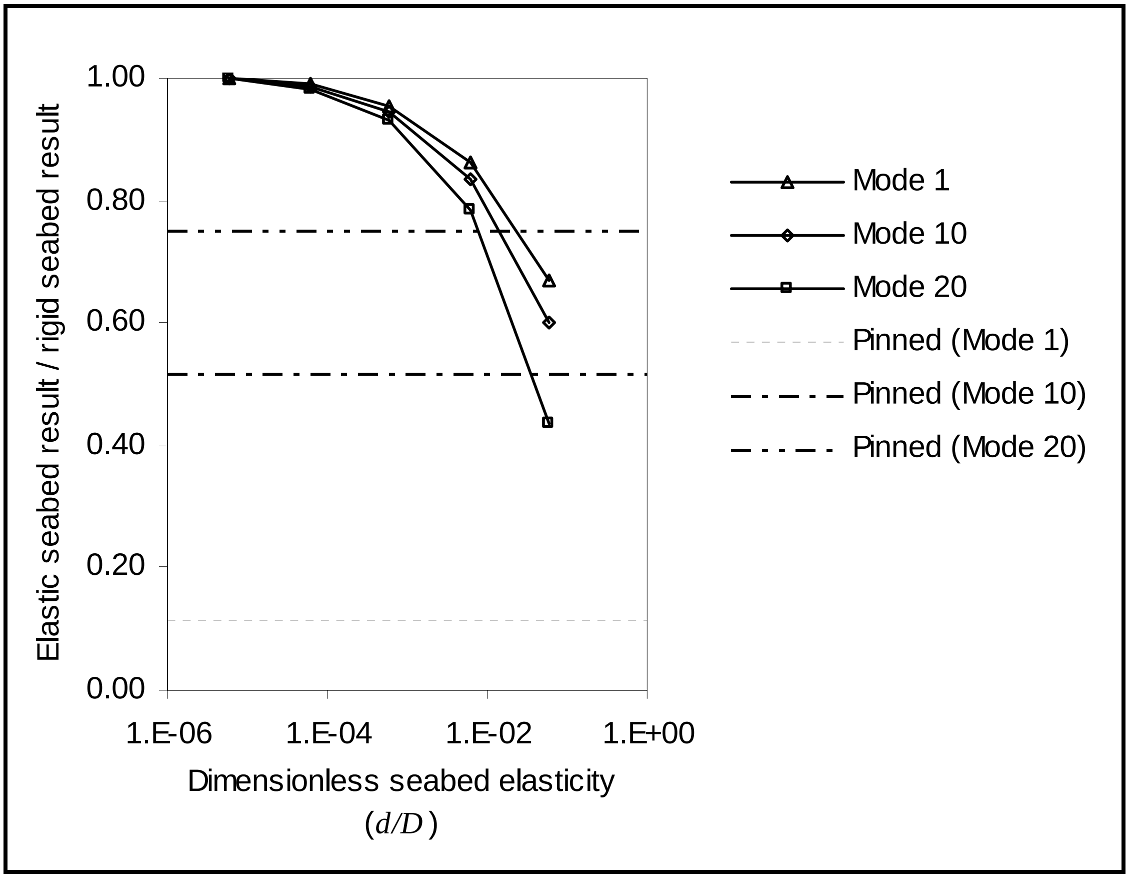

Figure 7-1: Touchdown Point Curvature versus Seabed Elasticity

Formulae have been developed to calculate the contact stiffness that should be used in this type of model, as a function of the expected trench depth and the measured soil properties (e.g., for clays, the shear strength and bulk modulus), and although the soils in the deepwater Gulf of Mexico are generally considered to be soft to medium strength clays, the stiffness derived for these soils is typically high such that the model is in the plateau region (d/D < 1E-4) and the fatigue damage is therefore not particularly sensitive to further increase in the assumed stiffness.

Most often the model will include friction to provide resistance to sliding of the riser in the lateral direction, when in contact with the seabed. In some cases, an elastic stiffness model has been used to provide lateral resistance but this type of model is more prone to numerical difficulties. In either case, the fatigue due to riser motion in the lateral direction is usually negligible in comparison with the fatigue caused by the riser being raised and lowered from the seabed. The fatigue due to the riser lateral motions is often referred to as the out-of-plane fatigue and the fatigue due to the raising and lowering of the riser from the seabed is referred to as the in-plane fatigue.

With respect to extreme conditions, the critical location is usually further up the riser, in the sagbend region, and therefore is less likely to be affected by the presence of a trench. For example, analyses performed with a conventional seabed model have shown that the selection of elastic stiffness for extreme cases is not significant since it has minimal effect on the peak bending moment. However, for extreme offset in the out-of-plane direction, it is recognized that the riser movement may be resisted by the trench walls causing localized bending in that region. Neither friction nor elastic stiffness resistance in the lateral direction is expected to be able to accurately represent the behavior of the trench for large lateral movement of the riser.

As part of the Carisima JIP, Marintek (of Norway) have developed an advanced soil pipe interaction model for use with their general riser analysis software, Riflex. The Carisima soil model includes the effects of trench shape, as well as suction and side wall resistance. The objective of this activity is to compare the conventional and advanced Carisima pipe-soil interaction models in order to investigate the significance of the additional effects that are included in the advanced model.

7.2 Summary

Analyses were performed for both the conventional soil model and the Carisima model. The results of the analysis allows for a quantitative comparison between the two approaches. Non-linear time domain finite element methods were used, with application of fully-coupled platform motions.

The semi-submersible motions were applied since this was earlier found to be more critical than the SPAR for both fatigue and extreme conditions. Similarly, the analyses were performed for the oil riser, which was found to have a shorter fatigue life and higher extreme event utilization than the gas riser.

The models and load conditions used for the conventional and Carisima analyses were identical in all respects other than the soil-pipe interaction model.

7.2.1 Fatigue Damage

Near and Far Directions

It was found that the fatigue damage in the touchdown region is less for the Carisima model than for the conventional soil-pipe interaction model. The reduction was 36% for the near direction and 62% for the far direction. This appears to be a fairly significant improvement in fatigue performance.

Since the conventional seabed model provides a conservative representation of the soil-pipe interaction, it is recommended that the conventional model continue to be used for SCR design until further enhancement and validation of more advanced seabed models are complete.

Cross Direction

The fatigue damage resulting from the cross seastate case is much greater for the Carisima model than for the conventional seabed model. However, since the out-of-plane fatigue damage remains significantly less than the in-plane fatigue damage, this is not important and again it is concluded that the conventional seabed model is adequate.

7.2.2 Extreme Dynamics

For the comparison of soil-pipe interaction for extreme events, the 100-year hurricane condition was assessed.

Near and Far Offsets

For near and far offset conditions the maximum bending moment occurs in the sagbend region of the riser remote from the localized effects of interaction with the seabed. Consequently, and as expected, the Carisima model produced only a minor change in the results relative to the conventional seabed model. For the far case, the peak bending moment was found to reduce by 1.8%. For the near case, there was an increase of 0.6%. These results confirm that the conventional soil-pipe interaction model is adequate and appropriate for extreme analysis for near and far environment directions.

Cross Offset

As well as the conventional model with lateral friction, a sensitivity study was conducted to investigate the effect of lateral stiffness on the out-of-plane bending moments. It was found that although the Carisima model predicts considerably higher bending stress in the out-of-plane direction than the conventional model, it does not govern over the in-plane bending moment in the sagbend and so is not significant. The lateral stiffness model was found to be excessively conservative.

7.3 Design Methodology

7.3.1 General

In general, the methodology is very similar to that used for the global riser analysis described in Section 5. Therefore, this section describes only the aspects that are unique to this activity.

For this activity, all of the analyses were performed using the Riflex software. A model of the SCR was initially established in Riflex with a conventional soil model, to be used as the datum case against which to compare results obtained from the Carisima model. The datum model was then modified to include the advanced Carisima soil-pipe model.

7.3.2 Soil-Pipe Interaction Model

The seabed model used in the conventional model was exactly as described in Section 5. The soil properties used for the Carisima model are presented in Table 7-1.

The trench profile was established on the basis of results obtained from three static analyses using the conventional seabed model. These are performed for prescribed near and far platform offsets and for the platform at its neutral position, as described in the Carisima trench procedure document [Ref. 7]. The near and far offsets used are equal to two-thirds of the 100-year hurricane offset.

The trench profile used by the Carisima module is given by the product of linearly increasing and exponentially decaying functions. Constants are derived to provide the required trench depth and length. In this case, the depth is three pipe diameters for the fatigue cases and four pipe diameters for the extreme case.

Table 7-1: Carisima Soil Parameters

Parameter	Description	Unit	Fatigue	Extreme
General Clay Soil Data				
SU	Undrained shear strength	lbf/ft^2	53.9	55.6
WSOI	Submerged unit weight of soil	lbf/ft^3	18.8	20.0
SUG	Shear strength gradient	lbf/ft	13.7	13.7
POI	Poisson's ratio	-	0.45[(1)]	0.45[(1)]
ES	Void ratio	-	2.0[(1)]	2.0[(1)]
PIX	Plasticity index	%	68.5	64.0
OCR	Over-consolidation ratio	-	1.0[(1)]	1.0[(1)]
RMUU	Axial friction coefficient	-	0.2[(1)]	0.2[(1)]
RMUV	Transverse friction coefficient	-	0.2[(1)]	0.2[(1)]
RFVMX	Max transverse capacity ratio	-	2.5[(1)]	2.5[(1)]
Suction Data				
CC	Consolidation coefficient	sec/ft^2	7.11×10^4 [(2)]	7.11×10^4 [(2)]
TCO	Initial consolidation time	sec	43,200[(3)]	129,600[(4)]

Note:

1. Default value [Ref. 6].
2. Marintek report [Ref. 7].
3. 12 hours for fatigue analysis.
4. 36 hours for extreme analysis.

7.3.3 Mesh

Different finite element meshes were used for the fatigue and extreme conditions. Mesh refinement is made in the sag bend / touchdown region (element length of 0.5 m/1.64 ft) and close to the top connection as they are the locations with higher stresses in the pipe wall. The mesh details are given in Table 7-2 for fatigue analysis and Table 7-3 for extreme analysis.

Table 7-2: Finite Element Mesh – Fatigue Analysis

Segment Number	Segment Length (ft)	Number of Elements	Element Length (ft)	Distance Along Riser (ft)
1	2624.7	100	26.2	2624.7
2	328.1	25	13.1	2952.8
3	164.0	25	6.6	3116.8
4	131.2	40	3.3	3248.0
5	395.3	241	1.6	3643.4
6	131.2	40	3.3	3774.6
7	144.4	22	6.6	3919.0
8	288.7	22	13.1	4207.7
9	2099.2	80	26.2	6306.8
10	7345.7	140	52.5	13652.6
11	1312.3	50	26.2	14964.9
12	524.9	40	13.1	15489.8
13	65.6	10	6.6	15555.4
14	85.3	26	3.3	15640.7
15	9.8	6	1.6	15650.6
16	7.2	11	0.7	15657.8

Table 7-3: Finite Element Mesh – Extreme Analysis

Segment Number	Segment Length (ft)	Number of Elements	Element Length (ft)	Distance Along Riser (ft)
1	2493.4	95	26.2	2493.4
2	65.6	5	13.1	2559.1
3	32.8	5	6.6	2591.9
4	328.1	100	3.3	2919.9
5	1017.1	620	1.6	3937.0
6	656.2	200	3.3	4593.2
7	164.0	25	6.6	4757.2
8	65.6	5	13.1	4822.8
9	1484.0	57	26.0	6306.8
10	7345.7	140	52.5	13652.6
11	1574.8	60	26.2	15227.4
12	262.5	20	13.1	15489.8
13	65.6	10	6.6	15555.4
14	65.6	20	3.3	15621.1
15	29.5	18	1.6	15650.6
16	7.2	11	0.7	15657.8

7.4 Load Cases

Two load cases were considered; one for fatigue and the other for extreme event dynamics. Fatigue seastate no. 7 (Appendix A) was selected for the fatigue analysis as it was found to cause the most fatigue damage, and the 100-year return hurricane was selected for the extreme event dynamic loading. In both cases, three directions were considered: near, far and cross.

The maximum offsets for the semi-submersible for the 100-year return period hurricane event are presented in Table 7-4.

Table 7-4: Extreme Offsets for 100-Year Hurricane Event

Direction	Unit	Vessel Offset
Far	ft \ m	612 \ 186.5
Near	ft \ m	567 \ 172.7
Cross	ft \ m	583 \ 177.7

7.5 Results

7.5.1 Static Analysis

A comparison between the conventional and Carisima static models is summarized in Table 7-5. These results indicate that the two models are essentially identical with differences in model forces of less than 0.15%.

Table 7-5: Static Analysis Summary Results

Property	Unit	Conventional	Carisima	Difference
Effective Tension at Hang-Off	kip	1666.7	1667.7	1 (0.06%)
Maximum Bending Moment	kip ft	101.56	101.41	0.15 (0.15%)
Location	ft	3579	3579	0.0

7.5.2 Fatigue Analysis

Carisima Trench

The trench profile used for the fatigue analysis is presented in Figure 7-2.

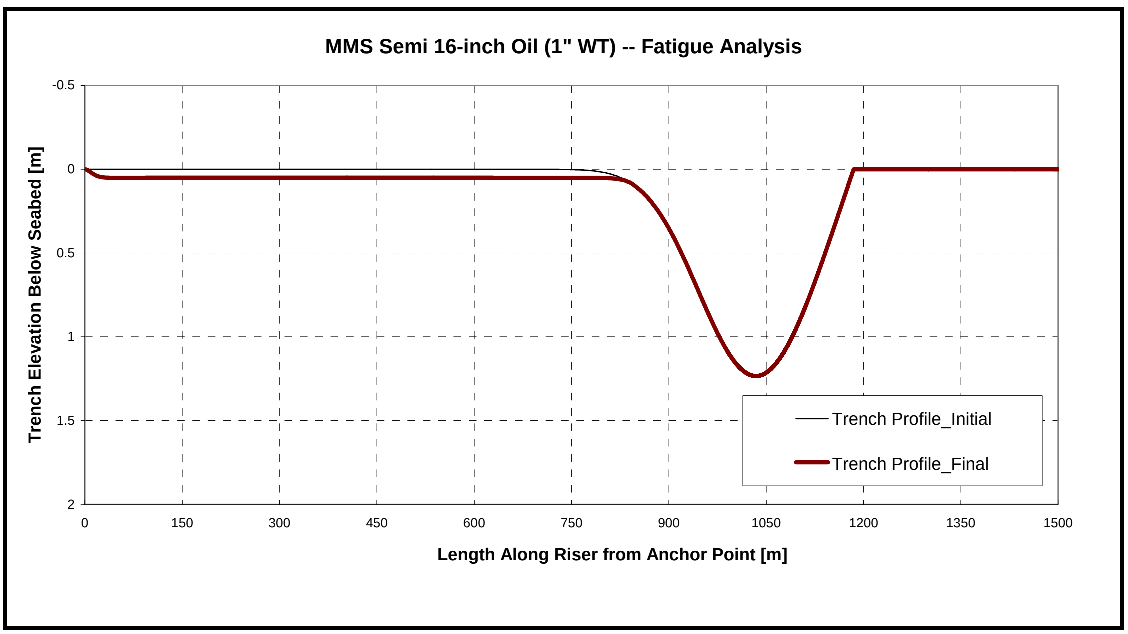

Figure 7-2: Trench Profile for Fatigue Analysis

Maximum Forces

The peak forces along the riser during the fatigue seastate are presented in Figure 7-3 through Figure 7-5.

The peak effective tensions are essentially the same except for a slight difference in the region of the riser that is on the seabed.

For the near offset case the peak bending moments are similar. The primary bending moment peak in the sagbend is 1.1% smaller in the Carisima model.

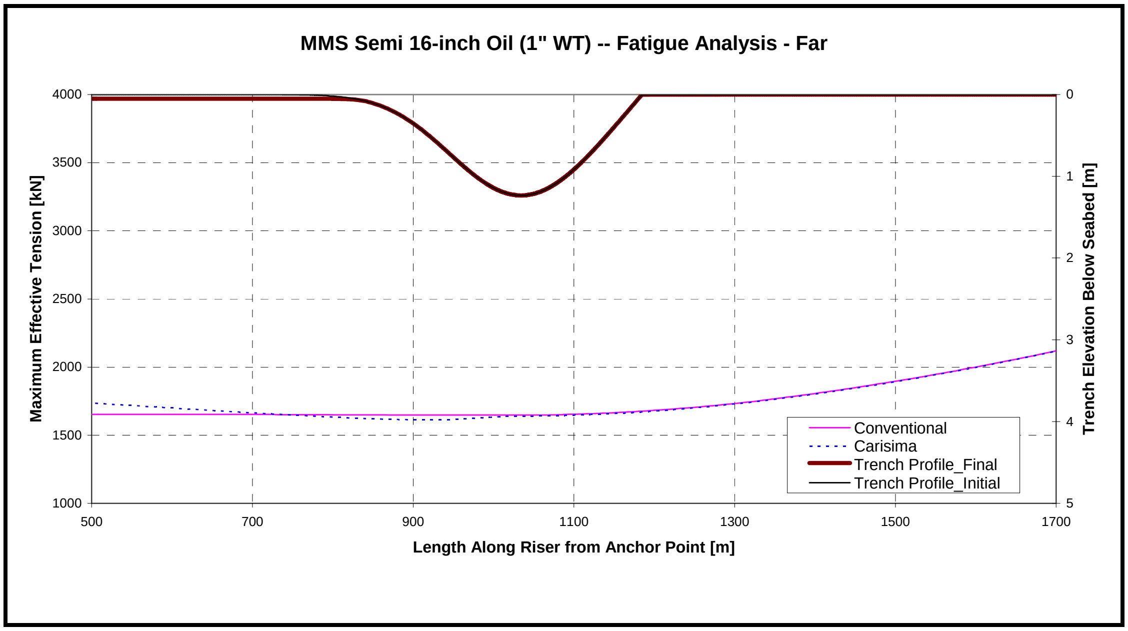

Figure 7-3: Maximum Effective Tension – Far Direction

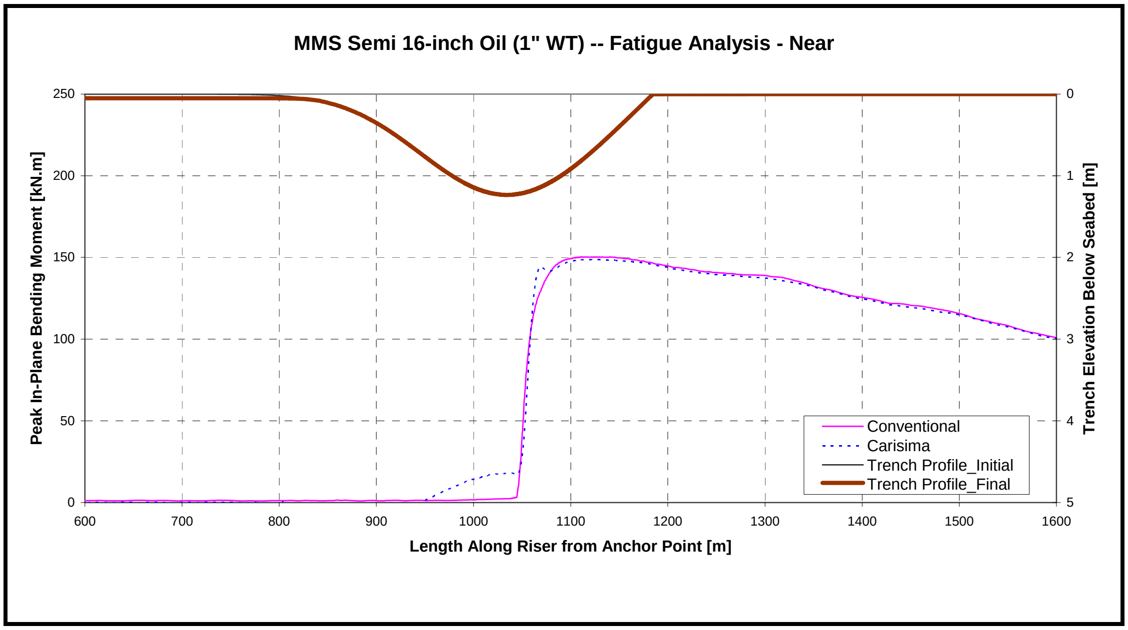

Figure 7-4: Maximum Bending Moment – Near Direction

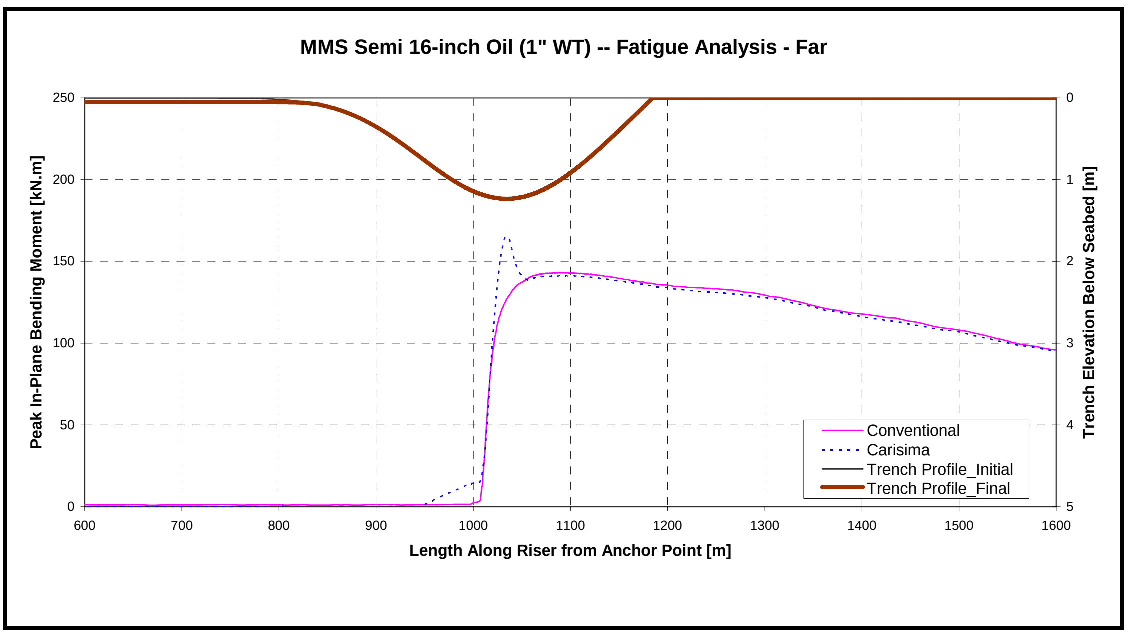

Figure 7-5: Maximum Bending Moment – Far Direction

Figure 7-6 presents the mean riser configuration and the touchdown region for the Carisima model. The relative occurrence of riser contact with the seabed is included. The riser is in constant contact with the seabed from a distance of 3415 feet (1041 meters) from the anchor point. The touchdown point region is 3415 to 3514 feet

(1041 to 1071 meters) from the anchor point, which is on the upward slope of the trench profile.

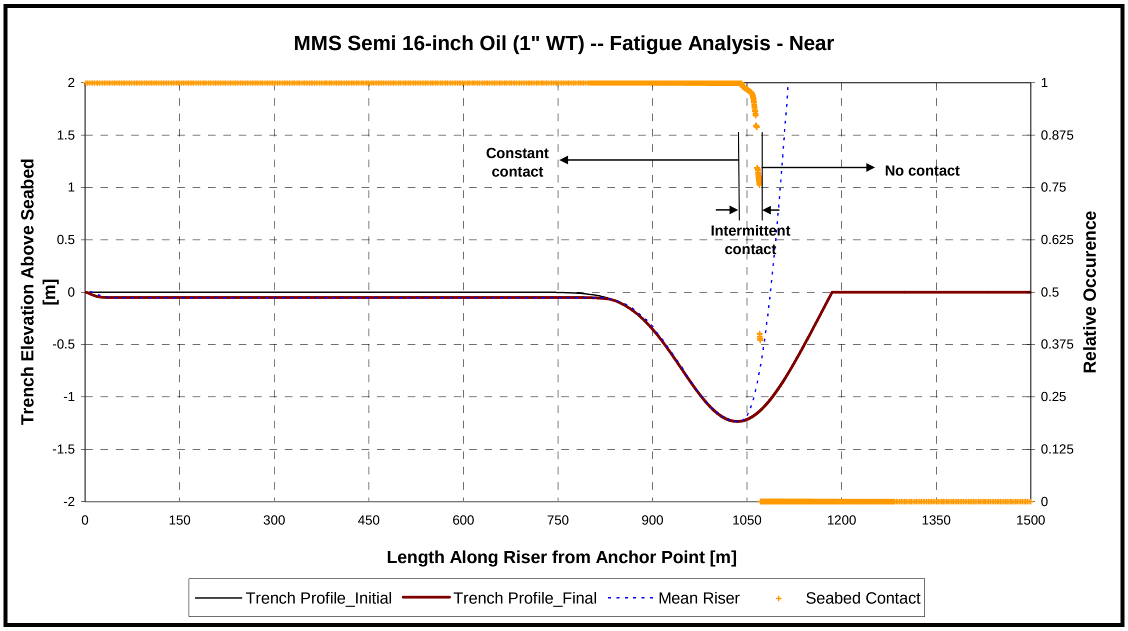

Figure 7-6: Riser Mean Configuration and Touchdown Region

Fatigue Damage

The FE numerical simulation results, for the selected fatigue seastate, are summarized in Table 7-6. Of primary interest is the bending moment and its fluctuation as this causes the stress cycles that result in fatigue damage to the riser. The magnitude of the in-plane bending moment standard deviation is smaller for the near, far and cross sea states in the Carisima model, as illustrated in Figure 7-7 and 7-8. Thus, a lower fatigue damage rate as is predicted by Carisima for the in-plane conditions.

Moreover, the fatigue damage resulting from the cross sea state case was insignificant as compared to the near and far cases at the TDZ. However, the Carisima soil model rendered relatively larger fatigue damage than the conventional model, in part due to the riser and trench interaction as observed in Figure 7-9.

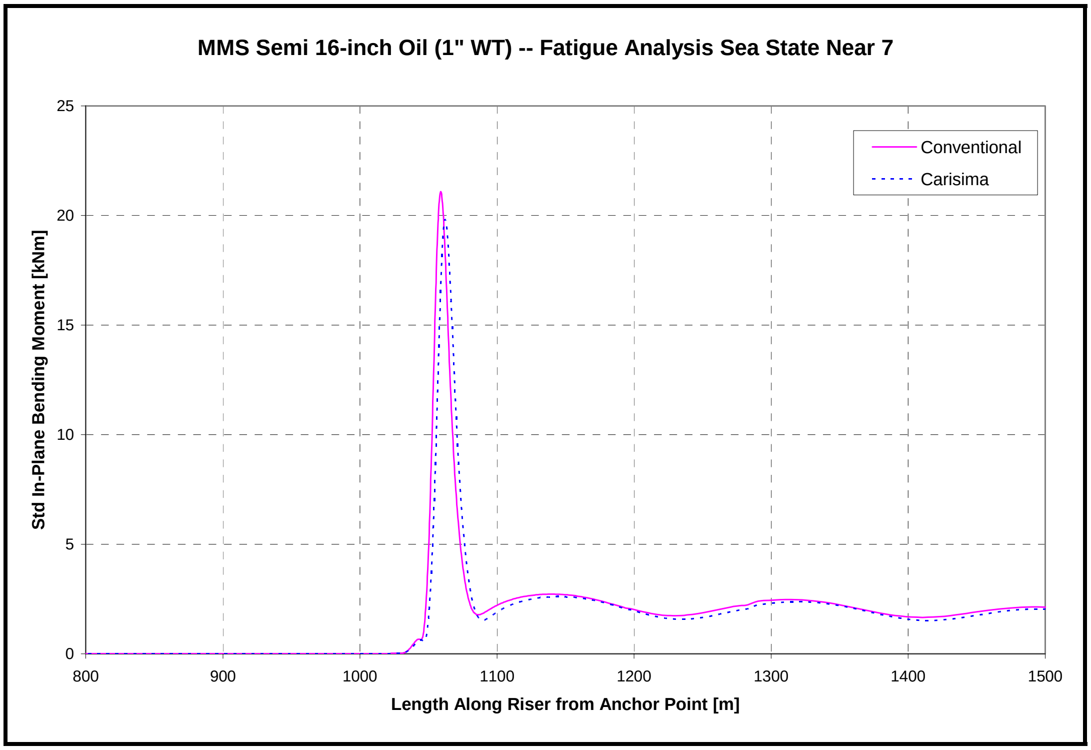

Figure 7-7: In-Plane Bending Moment Standard Deviation – Near Direction

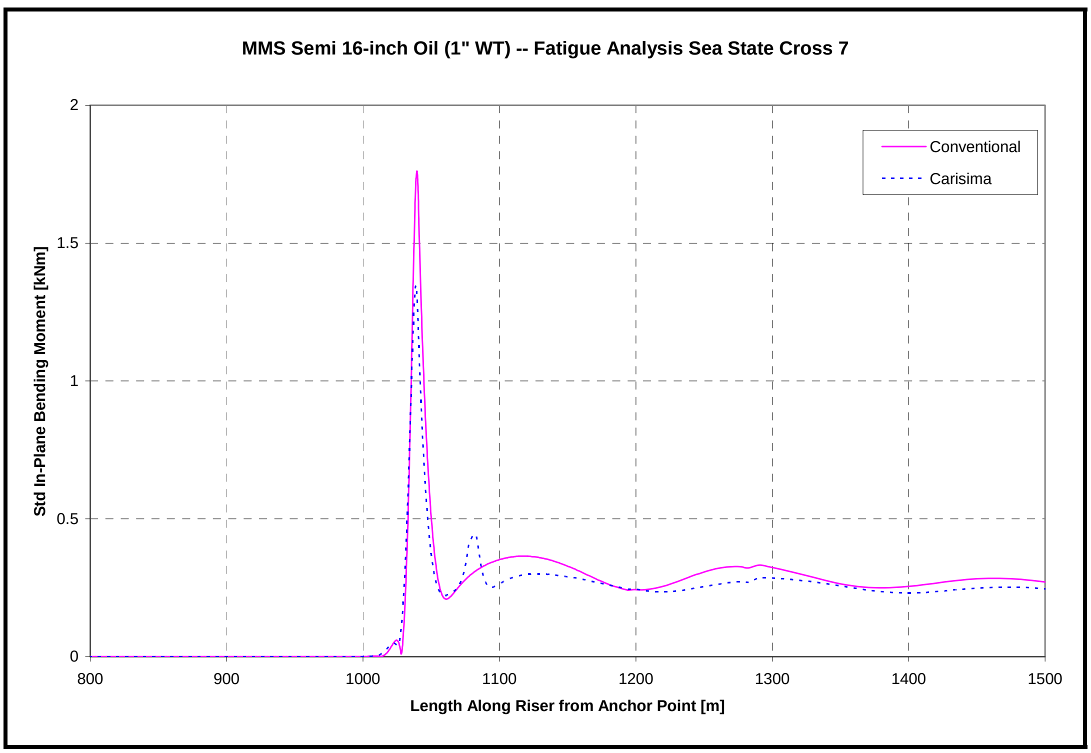

Figure 7-8: In-Plane Bending Moment Standard Deviation – Cross Direction

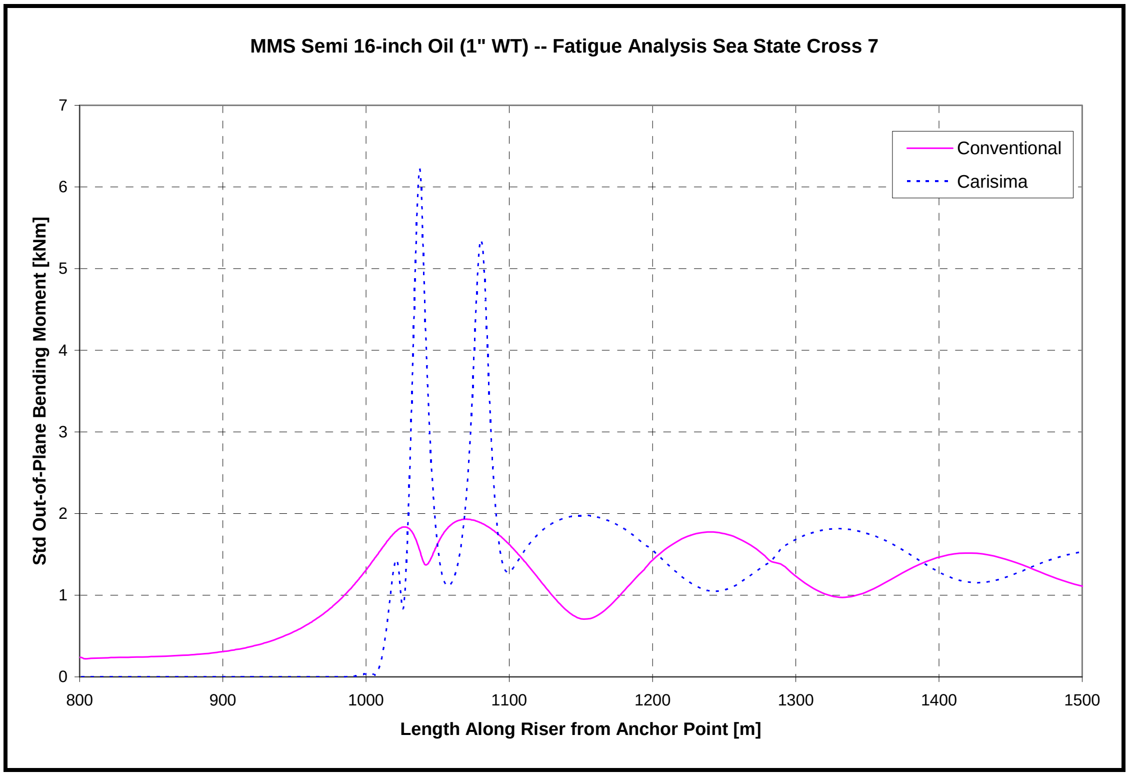

Figure 7-9: Out-of-Plane Bending Moment Standard Deviation – Cross Direction

The fatigue damage histograms from the Carisima model and conventional seabed model based on rainflow counting method are attached in Appendix B. These results indicate a significant improvement in fatigue performance for the Carisima model compared with the elastic seabed model, as quantified in Table 7-6. The location from the anchor point of the fatigue damage rate peak varies between 3353 to 3510 feet (1022 to 1070 meters) for the conventional soil model and 3394 to 3486 feet (1034.5 to 1062.5 meters) for the Carisima model.

Table 7-6: Fatigue Analysis Summary Results

Dir.	Result	Unit	Conventional	Carisima	Difference
Near	Max. Bending Moment	kip ft	110.93	109.75	1.18 (1.1%)
	Location	ft	3647	3663	16
	Max. Moment Std. Dev.	kip ft	15.56	14.63	0.93 (6.0%)
	Max. Fatigue Dam. Rate (1)	1/year	0.00965	0.00615	3.5×10^{-3} (36%)
	Location	ft	3473	3486	13
Far	Max. Bending Moment	kip ft	105.69	122.14	16.45 (16%)
	Location	ft	3568	3394	174
	Max. Moment Std. Dev.	kip ft	15.36	11.62	3.74 (24%)
	Max. Fatigue Dam. Rate (1)	1/year	0.00755	0.00283	4.7×10^{-3} (62%)
	Location	ft	3353	3394	41
Cross	Max. Bending Moment	kip ft	102.37	103.33	0.96 (0.9%)
	Location	ft	3594	3547	47
	Max. Moment Std. Dev.	kip ft	1.42	4.59	3.17
	Max. Fatigue Dam. Rate (1)	1/year	6.49×10^{-5}	8.18×10^{-4}	7.53×10^{-4}
	Location	ft	3510	3399	111

Note:

1. Fatigue damage based on outer-wall fiber, E curve with SCF of 1.00.

7.5.3 Extreme Analysis

Trench Profile

The Carisima trench profile was established using the same offsets adopted for the fatigue analysis, but for a depth of four pipe diameters. The trench profile for near sea state is presented in Figure 7-10.

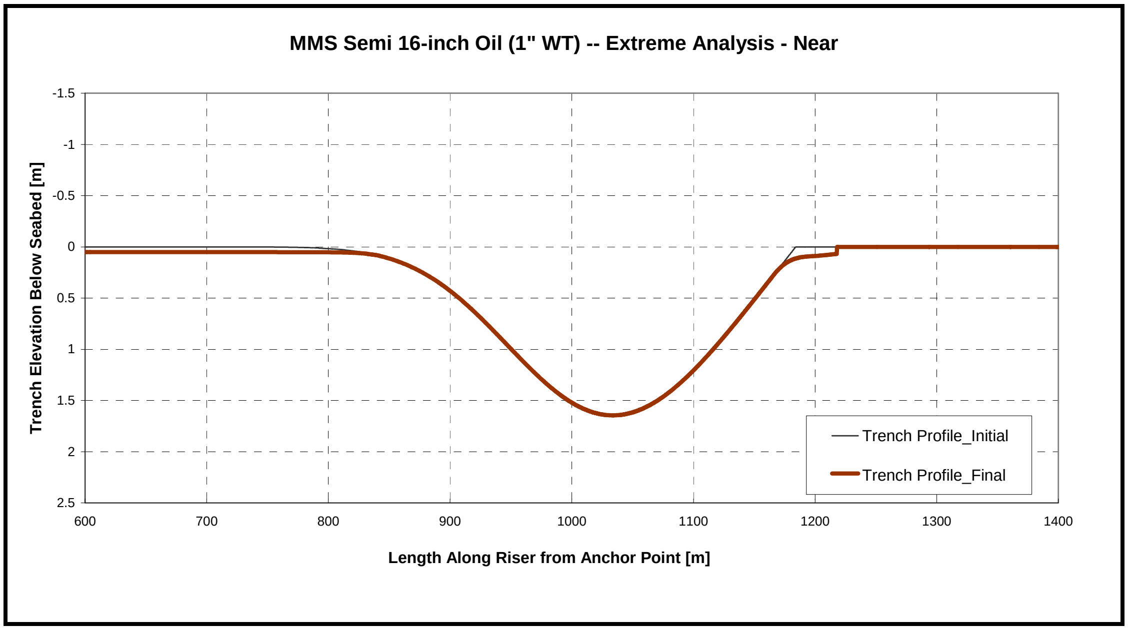

Figure 7-10: Trench Profile for Extreme Analysis

Extreme Bending Moments

The important result from the extreme analysis is the peak bending moment in the riser, since this governs the code check values. The near offset produces the maximum moment.

The peak effective tension for the far direction and the bending moment for the near and far directions are presented in Figure 7-11 through Figure 7-13. Table 7-7 quantifies the peak dynamic bending moment of the Carisima model. For the governing near direction, the Carisima result is 0.6% higher than that from the conventional model. For the far direction, the Carisima result is 1.7% higher.

Table 7-7: Maximum Moments – In-Plane Directions

Case	Parameter	Unit	Conventional	Carisima	Difference
Near	Maximum Bending Moment	kip ft	255.9	257.5	1.6 (0.6%)
	Location	ft	4216	4213	3
Far	Maximum Bending Moment	kip ft	199.8	196.5	3.3 (1.7%)
	Location	ft	2961	2949	12

There are differences in the tension and moment results in the region where the riser is in contact with the seabed. However, the difference in tension is not significant and the bending moment in this region is considerably less than in the sagbend region further up the riser, where there is much smaller difference between the results from the two models as shown in Table 7-7. For the near offset the sagbend moment governs the code check value, and so the higher bending moment in the touchdown region predicted by the Carisima model is not significant with respect to the riser integrity.

For a given environment, the cross-direction is found to be non-governing when using the conventional model. However, it is recognized that the conventional model may be inclined to underestimate bending in the out-of-plane direction since there is no explicit modeling of the resistance of lateral movement caused by the trench wall. It has generally been assumed that the riser would break free from the trench before the out-of-plane stresses become large and that consequently the in-plane bending in the sagbend region would still be governing.

For this assessment, another model was used in addition to the conventional model. This model used a stiff elastic model to resist movement in the lateral direction. The stiffness used was the same as that used for the vertical stiffness model. This type of model has been used to try to capture the lateral resistance provided by the trench wall.

The peak in-plane dynamic bending moments from all three models are in excellent agreement (within 1%) as presented in Table 7-8. However, the out-of-plane peak moments vary significantly. In particular it is seen that the lateral spring model results in a much higher bending moment than either the conventional or the Carisima model, and in fact for this case the out-of-plane bending moment predicted for the touchdown region governs over the in-plane bending moment in the sagbend. This is seen most clearly in Figure 7-14 and Figure 7-15. This difference is due to the fact that both the conventional and Carisima models allow the pipe to slip across the seabed thereby releasing the soil resistance transverse to the pipe and hence reduce the out-of-plane bending in the pipe.

Therefore, using a lateral spring model to capture the peak out-of-plane bending moment is shown to be too conservative. Furthermore, from a global point of view the Carisima model demonstrates that the peak bending moment occurs at the sagbend governed by the in-plane bending. Thus, the conventional model based on friction captures the extreme response well and the out-of-plane behavior of the model is not significant.

Table 7-8: Maximum Bending Moments – Cross Direction

Parameter	Unit	Conventional	Carisima	Lateral Spring
In-Plane Bending				
Maximum Bending Moment	kip ft	190.1	188.4	189.1
Location	ft	3627	3627	3622
Out-of-Plane Bending				
Maximum Bending Moment	kip ft	46.4	70.3	301.7
Location	ft	2992	3002	3212

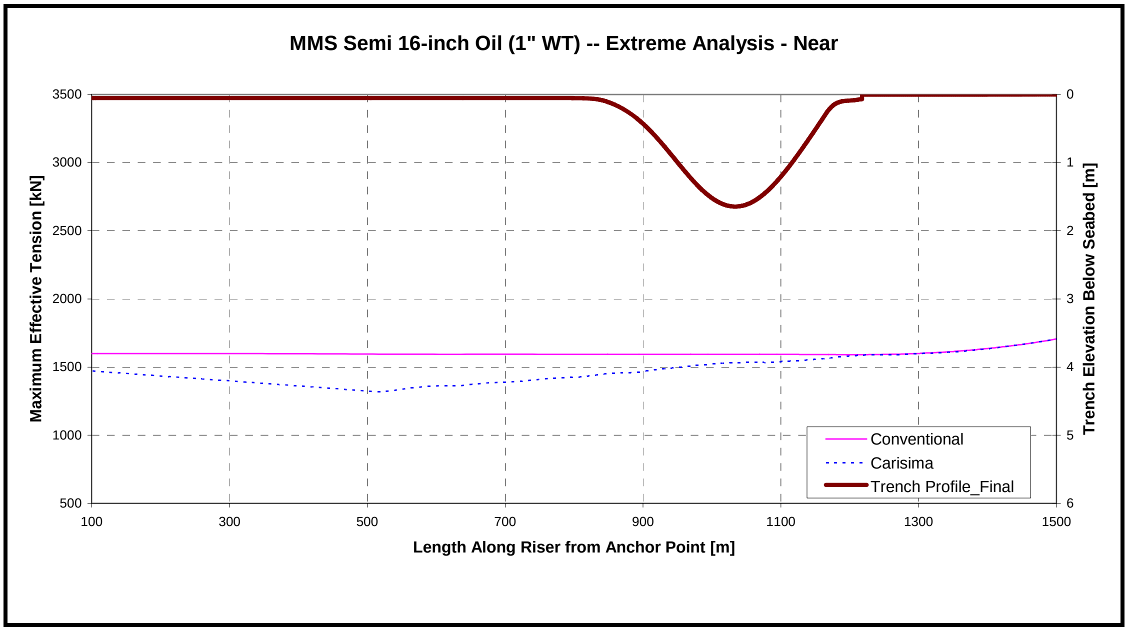

Figure 7-11: Effective Tension – Near Direction

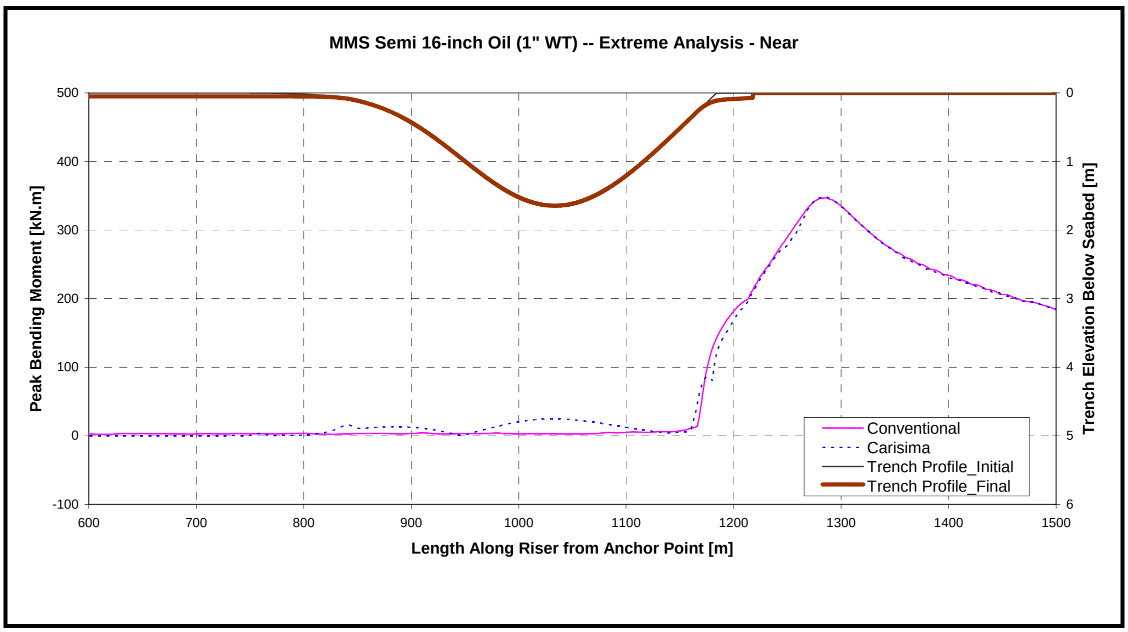

Figure 7-12: Bending Moment – Near Direction

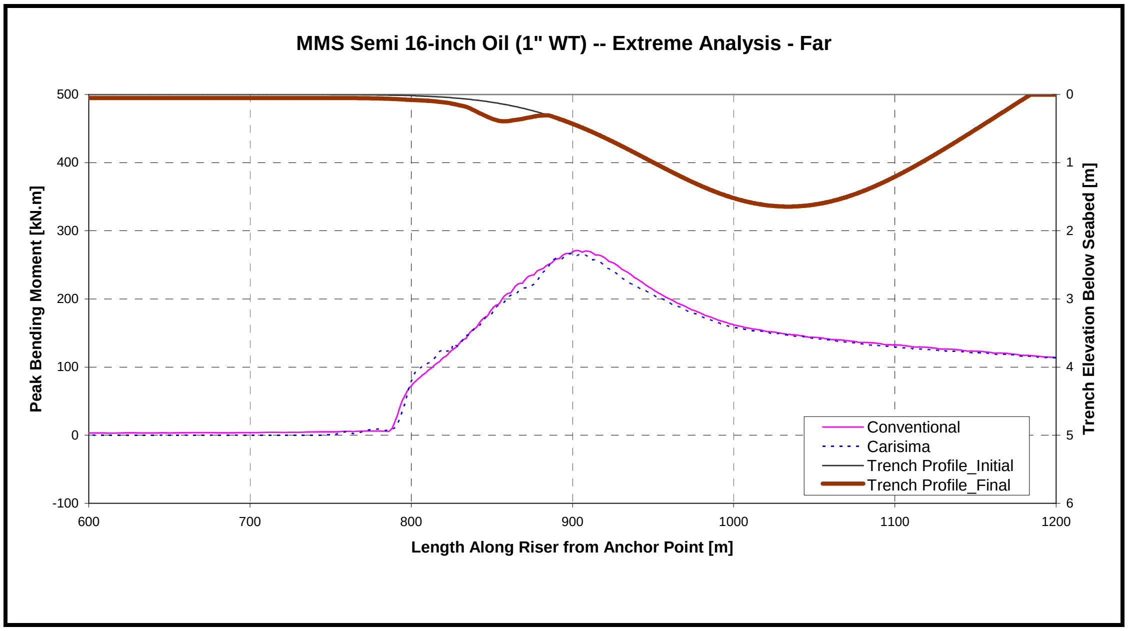

Figure 7-13: Bending Moment – Far Direction

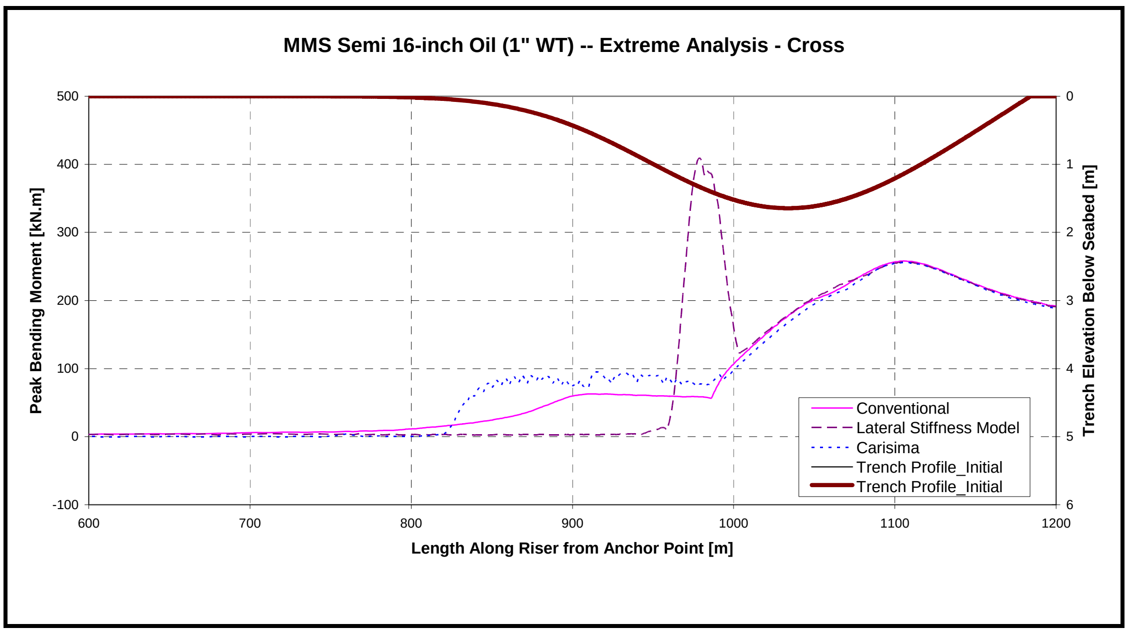

Figure 7-14: Bending Moment – Cross Direction

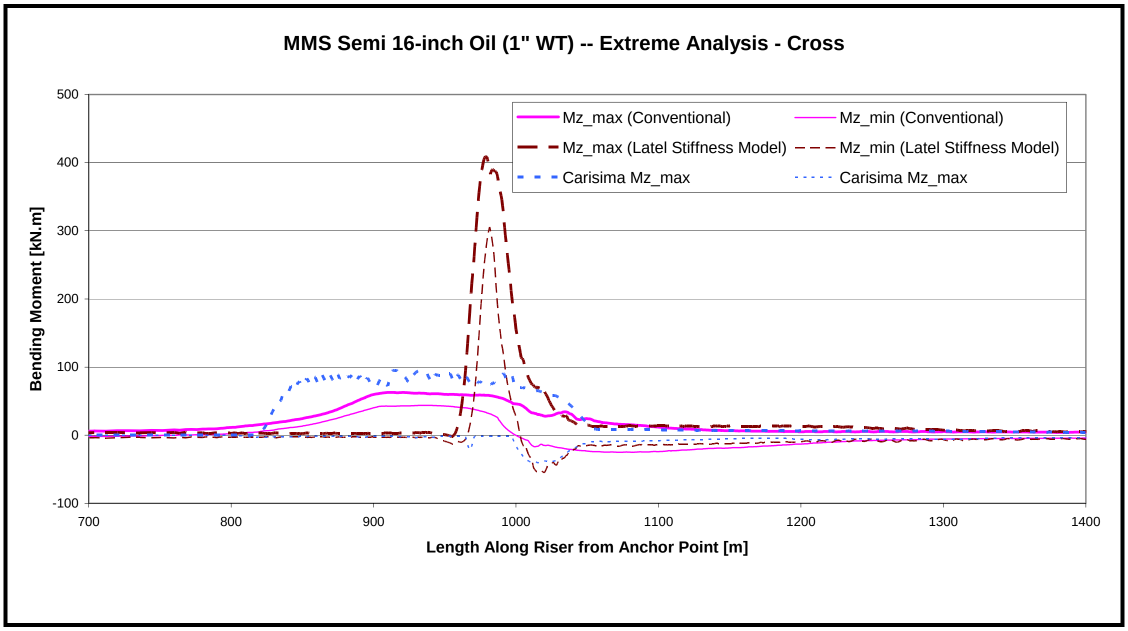

Figure 7-15: Out-of-Plane Bending Moment – Cross Direction

7.6 Conclusion

For selected fatigue and extreme conditions, analysis was performed using the advanced Carisima soil-pipe interaction model. The results were compared with equivalent results from a conventional soil-pipe model.

It was found that there was a moderate to significant improvement in the fatigue life for the Carisima trench model cases. These results tend to indicate that the conventional model is conservative. However, since the Carisima model is relatively new, it is considered that the results should be treated with some caution. Specifically, it is recommended that the conventional model continue to be used until further investigation of the Carisima work is completed. However, in the longer term, such advanced soil-pipe interaction models may be useful for obtaining a more accurate estimate of the fatigue in this critical region.

With respect to extreme conditions, it was found that accurate modeling of the seabed is not a significant consideration because the maximum stresses occur higher up the riser in the sagbend region. With respect to modeling restraint in the out-of-plane direction using a conventional model, it was found that friction is a more appropriate choice than elastic stiffness, since the latter option can tend to provide excessively conservative (unrealistic) results. Although the friction model may underestimate the stresses caused by lateral movement of the riser, this is unlikely to be important since the sagbend extreme stress is generally much greater.

8. TOUCHDOWN BEHAVIOR – TDP MOBILITY IN VIV ANALYSIS

8.1 Background

It is industry practice to analyze Steel Catenary Risers (SCRs) in the time domain, in order that non-linear behavior such as riser-seabed interaction can be accurately modeled. However, Vortex-Induced Vibration (VIV) assessments often use modal displacements and curvatures calculated using a standard modal analysis, which cannot account for such non-linear behavior. This activity reviews the suitability of the modal approach for VIV analysis of SCR riser systems.

Damage around the touchdown point of an SCR is generally much greater than that found elsewhere on the riser, as shown by the example in Figure 8-1. Noting that fatigue damage is proportional to some power of the stress amplitude, it is clear that any inaccuracy in stress range is amplified when predicting fatigue life. It is therefore important to accurately calculate stress ranges in the TDP region.

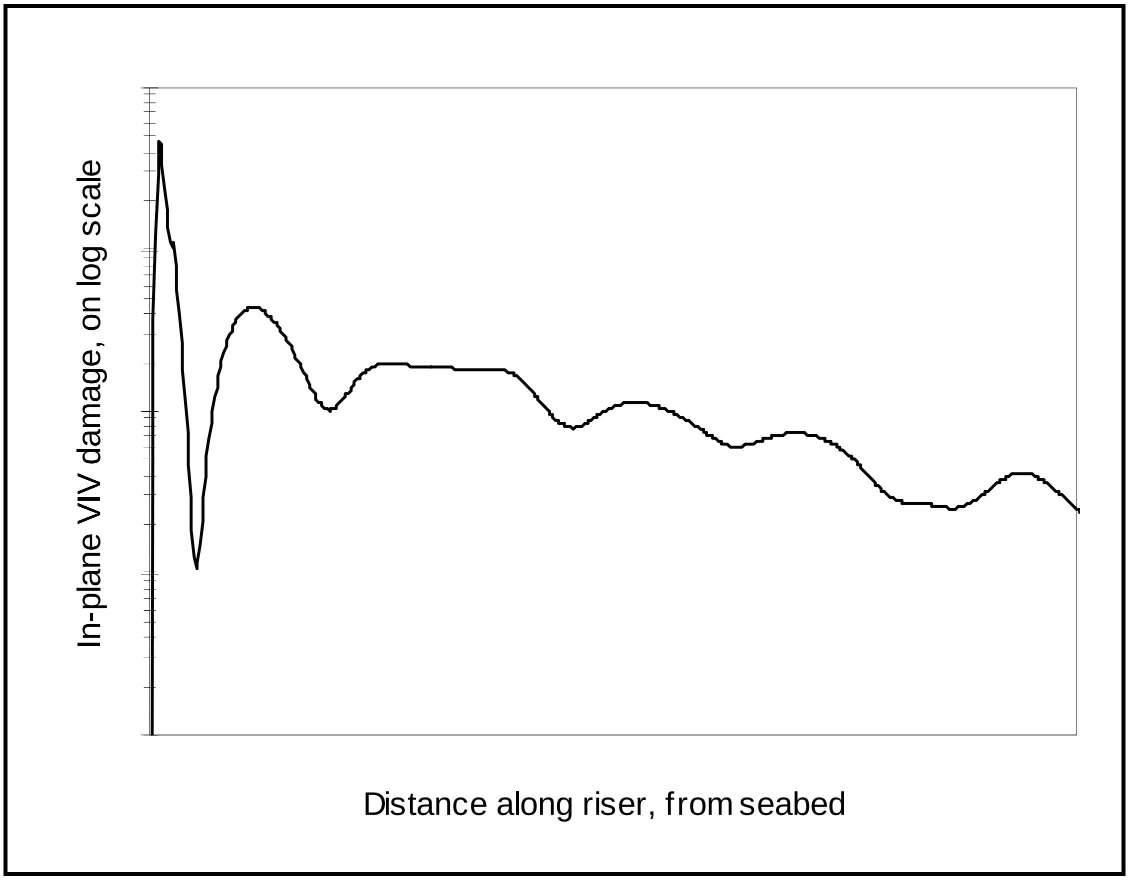

Figure 8-1: Damage from In-Plane VIV

8.2 Standard Procedure VIV Analysis

The following is a standard procedure for assessing VIV damage to SCRs using Shear7.

- An initial non-linear FE analysis provides the SCR static configuration, about which the modal analysis is performed.
- A finite element (FE) model of the riser is established and a modal analysis is performed to obtain modal data, i.e., natural frequencies and corresponding mode shapes.
- Using the riser natural frequencies, Shear7 is used to predict VIV response for given current profiles.
- From the modal curvatures and VIV response, fatigue damage rates are calculated within Shear7 for each profile.
- Total damage due to VIV is given by the sum of occurrence-weighted damage for a statistically representative number of profiles.

Using modal analysis to provide curvatures is considered to be reliable, and is a well-established approach. For top-tensioned risers, this is likely true, since the displacements are small with respect to the applicability perturbation theory, even for large VIV response amplitudes (e.g., A_{max}/D on the order of 1).

Away from the TDP region, the SCR is very much like a vertical riser with the addition of a slight static curvature. This curvature has little effect on the modal behavior of the SCR at VIV response amplitudes, to the extent that natural frequencies, displacements and curvatures could be calculated reasonably well, using a vertical model with the same effective tension distribution. Therefore, it is reasonable to expect that remote from the TDP region, a standard modal approach is as suitable for SCRs as it is for vertical risers.

However in the TDP region the SCR behavior is non-linear even for small displacements, due to the intermittent contact condition with the seabed, i.e., the fact that the TDP can move. Prior to performing modal analysis, the model used for the non-linear static analysis is linearized. This involves computing the system tangent stiffness matrix at the static equilibrium position. A necessary effect of this linearization is that the nonlinear unilateral contact condition becomes a linear elastic foundation with the TDP fixed at its static position. This is shown in Figure 8-2.

For high seabed stiffness, this consequently tends toward a fully built-in boundary condition as shown. This appears to be a significant departure from the real physical behavior at the touchdown point and therefore it is not clear whether the modal analysis will provide accurate stresses in this region. The main goal of this activity is to assess the significance of this effect.

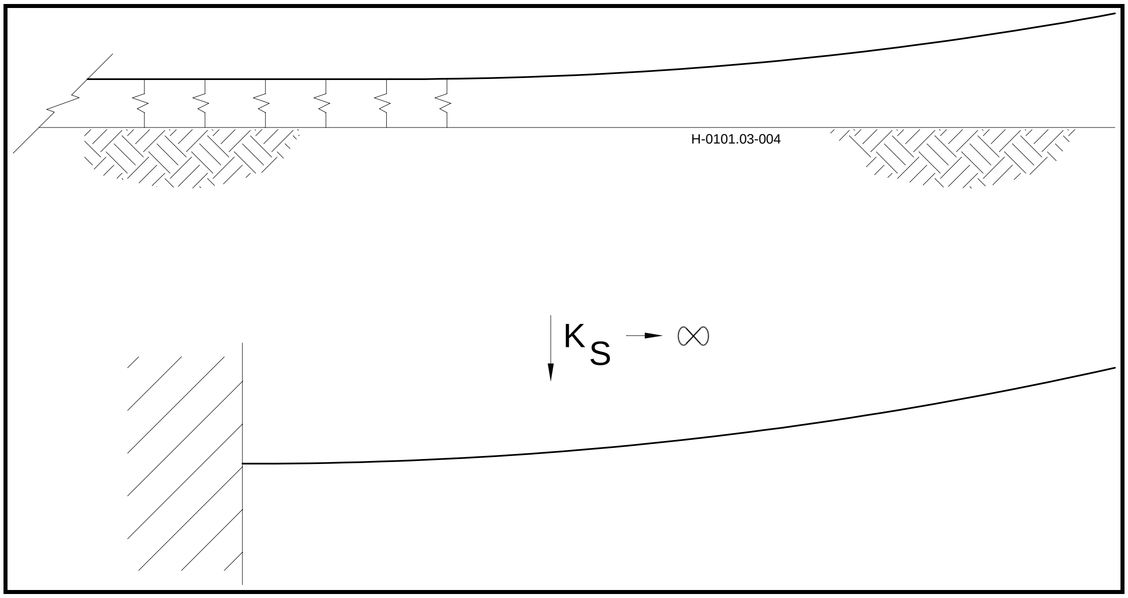

Figure 8-2: Modal Analysis Touchdown Point Boundary Condition

8.3 Modal vs. Non-Linear Touchdown Point Curvature

The effect of the aforementioned linearization on SCR curvature was investigated by comparing the linearized modal response with the response obtained from non-linear time domain (TD) simulations in which the SCR is excited in a single mode.

The nonlinear dynamic analysis was performed with a time-varying sinusoidal rotational displacement applied to the top of the SCR. The frequency of excitation was set to that of a known mode, as found from initial modal analysis.

The displacement amplitude was increased through a range appropriate for VIV lock-in. This was achieved by including a high level of structural damping initially, which was then phased out over time to allow a full undamped response to develop.

Displacement and curvature time histories along the riser were then normalized to obtain amplitudes equivalent to those produced by the modal analysis method.

8.4 Results

It was confirmed that displacement amplitudes along the SCR were consistent with the excitation amplitude and frequency. The normalized curvature plots from the TD analysis were then compared with those from the modal analysis. Figure 8-3 and Figure 8-4 show the results for modes 5 and 10 respectively. It can be seen that the curvature amplitude is very similar in the suspended region of the riser. This confirms good correlation of the TD method with the modal analysis method for the region of SCR away from the TDP region.

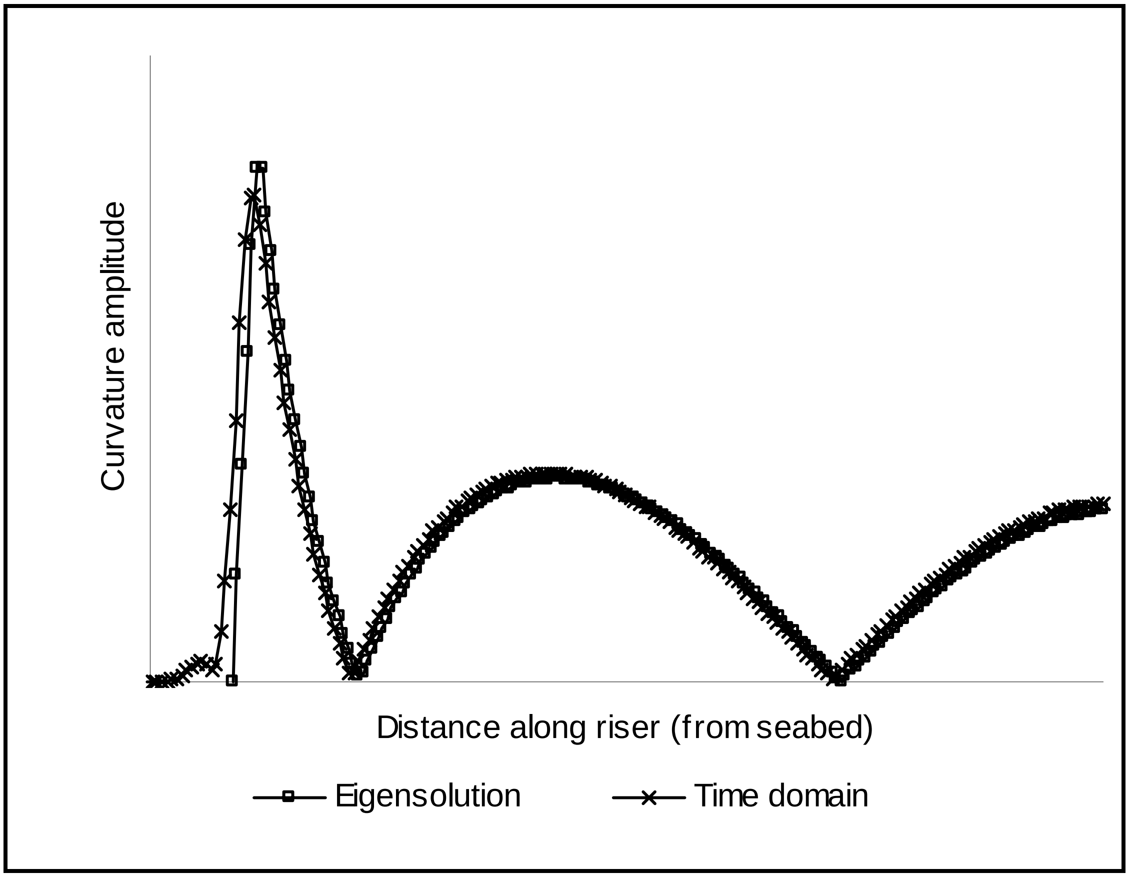

Figure 8-3: Curvature – Mode 5, $A_{max}/D = 0.8$

Figure 8-3 shows that for mode 5, with a dimensionless modal amplitude $A_{max}/D = 0.8$, the nonlinear response is in good agreement with the modal analysis in both the TDP region and over the main part of the riser. This shows that the modal analysis provides an accurate representation of the real nonlinear behavior in the touchdown region for this case.

However, as mode number and or displacement amplitude increase, this is no longer true and it is clear that the modal analysis approach can significantly overestimate the curvature in the touchdown region. Figure 8-4 shows this clearly for mode 10 with $A_{max}/D = 1.2$. It is important to note here that the curvature in the suspended region of the riser is very similar in both cases, indicating that the modal analysis is accurate in this region. However, the nonlinearity at the touchdown point, due to the mobility of the touchdown point, is clearly becoming more significant.

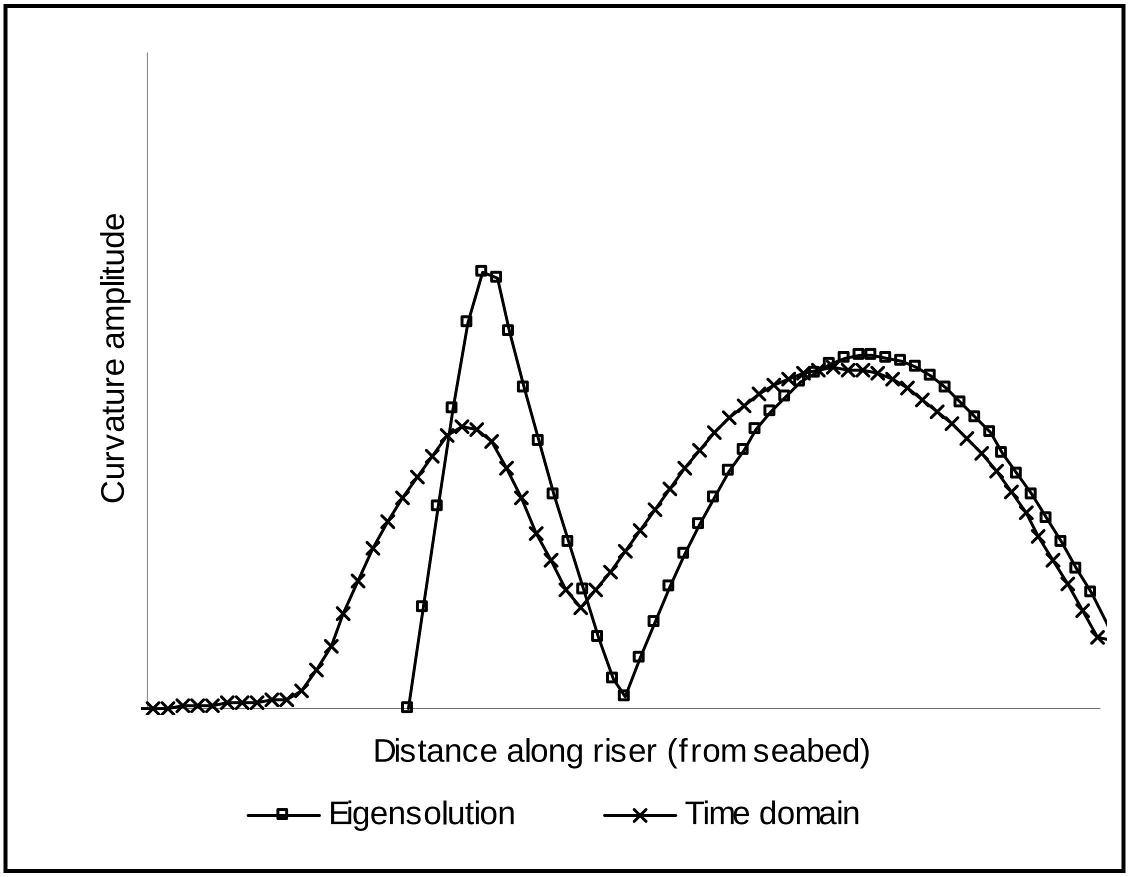

Figure 8-4: Curvature – Mode 10, $A_{max}/D = 1.2$

Figure 8-5 shows how the results compare over a range of response amplitudes, for the first ten in-plane modes. There is a clear trend for the modal analysis method to over estimate the TDP curvature compared to the more realistic TD method. The over estimation is noted to increase with both mode number and SCR response amplitude A_{max}/D. For high mode and displacement combinations, the discrepancy is seen to be significant especially when considering the power nature of fatigue damage.

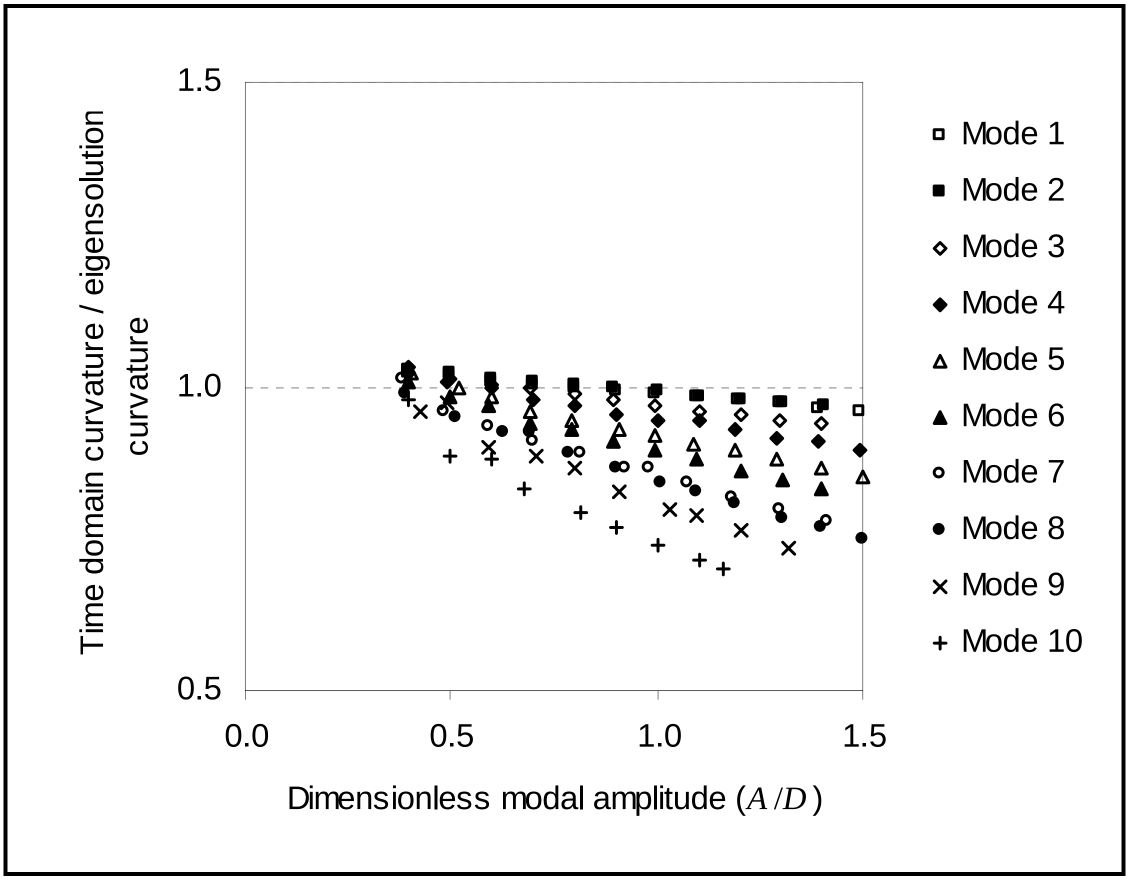

Figure 8-5: Curvature versus Modal Amplitude

Figure 8-6 shows the same time-domain versus modal analysis comparison, this time with varying mode number at constant response amplitude. The overestimate of curvature obtained from the modal analysis also appears to be approximately linearly proportional to mode number.

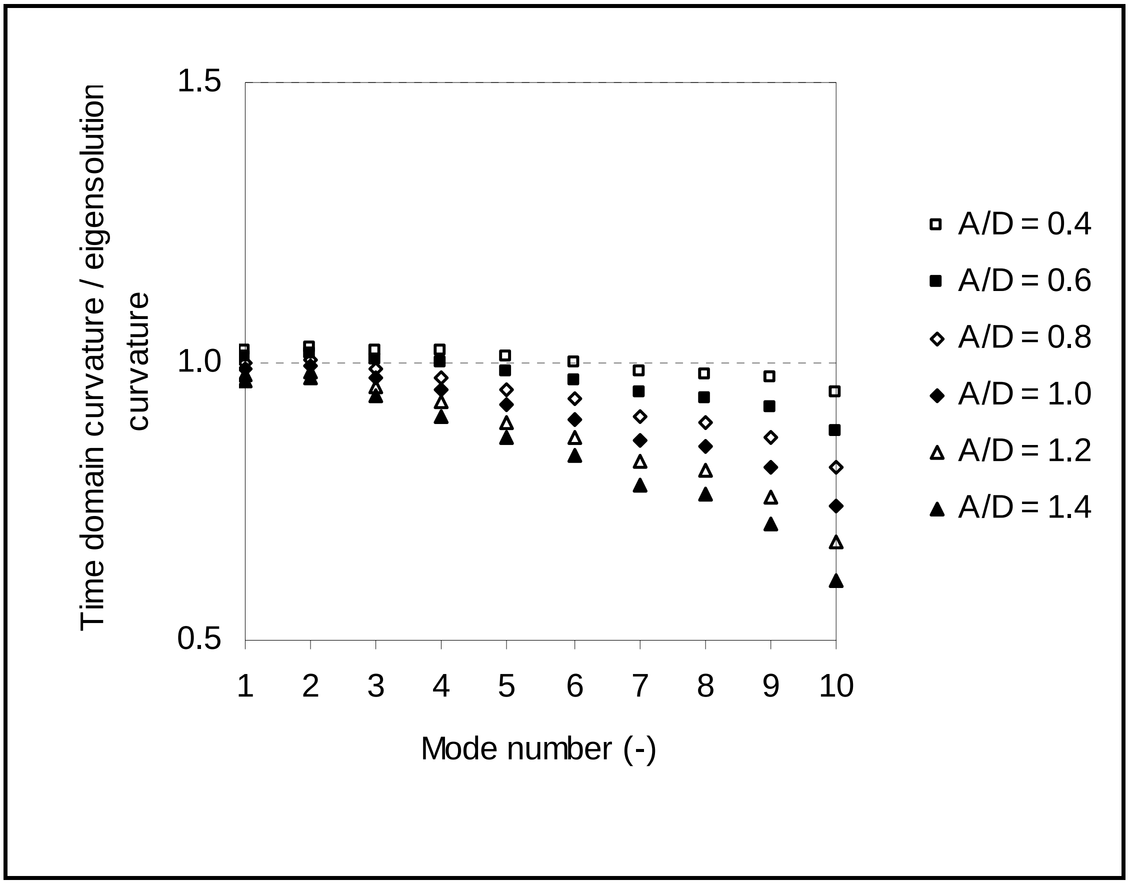

Figure 8-6: Curvature versus Mode Number

Using an elastic foundation model, the modal analysis method accurately calculates SCR curvatures in the touchdown region for low frequency modes, and for small displacement amplitudes.

The modal analysis method does not accurately predict SCR curvatures in the touchdown region for high frequency modes or where the displacement amplitudes are large. In this situation, the modal analysis can significantly over estimate curvature in the touchdown region.

Deepwater SCRs typically have strakes to minimize the VIV response. This will tend to keep the response amplitudes to a level where the modal analysis method is accurate or only marginally conservative. Furthermore, the general inaccuracy associated with VIV prediction may well be more significant than the error associated with simplified modeling of the seabed. Nevertheless, it is recognized that there are methods available that could allow touchdown point mobility to be included in VIV analysis. This is discussed in the following section.

8.5 Improved Modeling Procedure

One option for including touchdown point mobility is to perform the VIV analysis in the time domain. Considerable efforts are being made to improve the accuracy and efficiency of time-domain VIV analysis, for example through the DEEPSTAR JIP. This option is not considered in more detail here.

Another option is to use the modal acceleration method to convert the frequency domain VIV response into the time-domain and apply it to a nonlinear model including a mobile touchdown point. The validity of this approach is based on the following basic assumptions

- Local TDP behavior is not important for global VIV hydrodynamic response.
- Local TDP behavior is important for stress recovery local to the TDP.

The first of these assumptions is implicit in the standard VIV procedure adopted with Shear7. To accommodate the second assumption, the SCR stress and fatigue calculations would be performed using the original finite element model that was used for determination of the natural frequencies and mode shapes.

The key benefits of this method are as follows:

- Per the objective, it is possible to re-introduce touchdown point mobility into the solution. This is anticipated to improve stress prediction accuracy and avoid excessive conservatism as per the previous discussions.
- Modes that are not active in the VIV dynamic response would contribute statically to the solution. The inclusion of these additional degrees of freedom is also generally anticipated to improve accuracy.
- The finite element model can use a fine mesh around the touchdown region to improve stress recovery accuracy.
- Fatigue calculation can be based on rainflow cycle counting methods as an alternative to statistical methods.
- Other more advanced nonlinear soil models could be included in the VIV calculation, e.g., Carisima.

8.6 Conclusion

Using an elastic foundation model, the modal analysis method accurately calculates SCR curvatures in the touchdown region for low frequency modes, or where displacement amplitudes are small. This is the dominant condition for real SCRs since strakes are used to minimize VIV response.

The modal analysis method does not accurately predict SCR curvatures in the touchdown region for high frequency modes or where the displacement amplitudes are large. In this situation, the modal analysis can significantly over estimate curvatures in the touchdown region.

The modal acceleration method would improve accuracy and allow TDP mobility to be accounted for. However, at this time, the benefit from this enhancement to VIV analysis procedures is considered to be marginal since the inaccuracy in the touchdown point modeling for straked SCRs is probably not significant relative to the overall inaccuracy of VIV prediction.

9. REFERENCES

1. Martec; “Probabilistic Reliability and Integrity Assessment of Large Diameter Steel Compliant Risers (SCRs) for Ultra-Deepwater Operations: Volume 2 – Reliability Analysis”, Ref. TR-06-27 (issued with this report).

2. INTEC; “Design Assumption for Study Topics”, Ref. 11172601-001-DBD-001 (attached as Appendix A).

3. Century Dynamics; AQWA, Version 5.4.

4. ANSYS Inc.; ANSYS, Version 9.

5. MCS; Flexcom, Version 7.1.

6. Marintek; RIFLEX, Version 3.4.

7. Marintek; “The CARISIMA Trench Procedure”, Ref. 700039, 25 Jan 2002.

8. MIT; SHEAR7, Version 4.4.

APPENDIX A

DESIGN BASIS

MMS SCR INTEGRITY STUDY

PROBABILISTIC RELIABILITY AND INTEGRITY ASSESSMENT OF LARGE DIAMTER STEEL COMPLIANT RISERS FOR DEEPWATER

DESIGN ASSUMPTIONS FOR STUDY TOPICS

PREPARED FOR

US DEPARTMENT OF THE INTERIOR MINERALS MANAGEMENT SERVICE

INTEC PROJECT NUMBER 11172601

0	30-Jun-2006	Issued for Use	CM	AT	CM	
Rev.	Date	Description	By	Chkd	Appd	Client

INTEC ENGINEERING	11172601-001-DBD-001

TABLE OF CONTENTS

1. INTRODUCTION

The United States Department of the Interior Minerals Management Service (MMS) has contracted INTEC Engineering and Martec to carry out a number of studies into various aspects of Deepwater Steel Catenary Riser (SCR) design. This document provides the data required to carry out these studies. It is intended to be a live document which will be updated during the course of the project.

2. CODES, STANDARDS AND SPECIFICATIONS

The applicable federal regulations that establish the minimum requirements for the flowline risers are:

- DOT 49 CFR 192, Transportation of Natural and Other Gas by Pipelines: Minimum Federal Safety Standards
- DOT 49 CFR 195, Transportation of Hazardous Liquids by Pipeline
- DOI 30 CFR 250, Oil and Gas and Sulphur Operations in the Outer Continental Shelf.

Design of risers are required to meet the requirements of;

- API RP 1111, “Design, Construction, Operation and Maintenance of Offshore Hydrocarbon Pipelines (Limit State Design)”, Third Edition, 1999.
- API RP 2RD, “Design of Risers for Floating Production Systems (FPSs) and Tension Leg Platforms (TLPs)”, First Edition, 1998.

3. GENERAL DESIGN PARAMETERS

An export SCR in 10,000 feet water depth, has been selected for these studies. A 16-inch outside diameter (OD) and a static departure (hang-off) angle of 12 degrees have been selected for the SCR.

This section presents assumed general design parameters and environmental data for the steel catenary risers (SCRs), to be adopted for study work.

3.1 Design Life and Fatigue Life

The design life of the SCRs is assumed to be 20 years. The required fatigue life for the SCR design is 200 years, which is 10 times the design life as per API RP 2RD. All sources of fatigue damage need to be considered. Note Spar VIM is not included in current study work.

3.2 Fluid Properties

The following fluid properties are to be used;

3.2.1 Density

Typical export fluid densities for deepwater Gulf of Mexico developments can be 55 to 56 lb/ft^3 for oil and 8 to 21 lb/ft^3 for gas products. Therefore for study work product density of 55 lb/ft^3 for oil and 16 lb/ft^3 for gas will be assumed.

3.2.2 Operating Temperature

The SCR’s will be assumed to operate at 120ºF (49ºC).

3.2.3 Maximum Allowable Operating Pressure (MAOP)

For the SCR’s the assumed MAOP is 3000 psi, at 100 feet above mean sea level.

3.3 Flexible Joint Data

Table 3-1 presents typical nominal flexible joint rotational stiffnesses for a 16-inch Flexjoint as provided by Oil States Industries (OSI) [Ref. 2]. Information on potential changes to flexible joint stiffness due to aging will be added at a later date.

Table 3-1: 16-Inch Export SCR Flexjoint - SCR Design Values for Flexjoint Rotational Stiffness

Alternating Angle (deg)	Nominal Predicted Rotational Stiffness (ft-kips/deg)	Design Rotational Stiffness (ft-kips/deg)
0.01	69.232	96.924
0.02	57.492	78.788
0.03	49.976	69.796
0.04	44.702	64.045
0.05	40.772	59.913
0.06	37.715	56.736
0.07	35.261	54.181
0.08	33.242	52.061
0.09	31.549	50.260
0.10	30.104	48.702
0.20	22.278	39.589
0.30	18.945	35.071
0.40	17.049	32.181
0.50	15.809	30.105
0.60	14.926	28.508
0.70	14.262	27.225
0.80	13.742	26.159
0.90	13.322	25.255
1.00	12.976	24.472
1.50	11.861	21.679
2.00	11.247	19.893
3.00	10.574	17.622
4.00	10.205	16.170
5.00	9.968	15.127
6.00	9.802	14.325
7.00	9.678	13.680
8.00	9.581	13.145
10.00	9.440	12.296
12.00	9.341	11.644
14.00	9.267	11.120

3.4 Soil Data

A vertical seabed stiffness of 224.8 kip/ft/ft (1000 kN/m/m) shall be assumed for this study. This is a typical stiffness associated with a Gulf of Mexico SCR, trenched in a soft clay.

3.5 SCR External Corrosion Coating

It will be assumed that the SCR will be coated externally with a layer of FBE. The SCR will also have a layer of Three Layer Polyethylene (TLPE) abrasion resistant coating covering the touchdown region.

3.6 Material Physical Properties

3.6.1 Grade and Type

Table 3-2 shows the steel pipe type and grade for the SCRs.

Table 3-2: Steel Pipe Grade and Type

Pipe	Nominal OD (in)	Grade	Pipe Type	Corrosion Allowance (in)
16-inch SCR	16	X-65	seamless	0

3.6.2 Densities

The material densities to be used in the analysis are given in Table 3-3.

Table 3-3: Material Densities

Material	Density (lb/ft^3)	Density (kg/m^3)
Carbon Steel	490	7850
FBE	87.4	1400
3-Layer Polyethylene	62.4	1000

3.7 Wall Thickness

The SCR minimum wall thickness will be selected to withstand;

- Internal Design pressure during operation
- Hydrotest Pressure
- Maximum allowable operating pressure
- External pressure during installation and during operation
- Bending and external pressure

Wall thickness will not be designed to limit buckle propagation. It will be assumed a buckle arrestor will be included in the pipeline section near the SCR/pipeline transition.

For the purpose of this study, a wall thickness of 1.0 inch is selected which satisfies the CFR and API design requirements.

3.8 Water Depth

A water depth of 10,000 feet is assumed for this study.

3.9 Wave Data

3.9.1 Extreme Wave Conditions

The 100-year return period hurricane data [Ref.1] is given in Table 3-4.

Table 3-4: 100-Year Return Period Hurricane

Seastate No.	Sig. Wave Height Hs (ft)	Wave Peak Period Tp (sec)	Wave Spectral Peaked Qp	Surface Current Velocity Vs (ft/sec)	Wind Velocity Vw (ft/sec)
100	40.3	14.2	2.7	4.20	137.3

The significant wave height is defined as the mean height of the highest one-third of all waves and is sometimes interpreted as the wave height that would be reported by a human observer. The expected maximum wave height in a 3-hour period is equal to 1.86 times the significant wave height.

3.9.2 Fatigue Seastates

Typical Fatigue seastates and associated wind and surface current for use in wave fatigue analysis for the Gulf of Mexico are given in Table 3-5 (taken from the Deepstar JIP [Ref. 1]). It will be assumed, for study work, that seastates are equally likely to approach from any compass direction.

Table 3-5: Fatigue Seastates for Waves and Associated Current and Wind

Seastate No.	Duration in 1 yr. n_i (hours)	Sig. Wave Height Hs (ft)	Wave Peak Period Tp (sec)	Wave Spectral (Jonswap) Peaked Qp	Surface Current Velocity Vs (ft/sec)	Wind Velocity Vw (ft/sec)
1	367	2.0	2.8	2.0	0.62	20.6
2	1932	2.0	4.2	2.0	0.62	20.6
3	893	2.0	5.6	2.0	0.62	20.6
4	712	4.0	4.2	2.0	0.98	32.8
5	1668	4.0	5.6	2.0	0.98	32.8
6	466	4.0	7.0	2.0	0.98	32.8
7	774	6.0	5.6	2.0	1.29	42.9
8	638	6.0	7.0	2.0	1.29	42.9
9	121	6.0	8.5	2.0	1.29	42.9
10	366	8.0	7.0	2.0	1.56	52.0
11	143	8.0	8.5	2.0	1.56	52.0
12	116	10.0	8.5	2.0	1.81	60.3
13	45	12.0	8.5	2.0	1.99	68.1
14	29	14.0	9.2	2.5	2.43	75.5
15	4.5	16.0	10.6	2.5	2.84	82.5
16	3.1	18.0	10.9	2.5	3.24	89.3
17	2.2	20.0	11.1	2.5	3.63	95.9
18	1.4	22.0	11.4	2.5	3.91	100.6
19	0.9	24.0	11.7	2.5	4.17	105.0
20	0.6	26.0	12.1	2.7	4.42	109.3
21	0.45	28.0	12.4	2.7	4.67	113.4
22	0.265	30.0	12.7	2.7	4.90	117.4
23	0.2	32.0	13.0	2.7	5.13	121.3
24	0.12	34.0	13.3	2.7	5.35	125.0
25	0.085	36.0	13.7	2.7	5.56	128.6
26	0.057	38.0	14.0	2.7	5.77	132.2
27	0.038	41.0	14.5	2.7	6.07	137.3
Total	8283.915					

The total number of hours is less than 8760 because seastates with a significant wave height of less than 2 feet have not been included.

3.10 Current Data

MMS has provided omni directional current speed at selected water depths in the Gulf of Mexico presented in Table 3-6, [Ref. 3]. They are 3-hour low-passed, which means that current fluctuations of 3 hours and less have been removed from the record.

Table 3-6: MMS Current Data

Depth (m)	Max speed (cm/s)	Mean Speed (cm/s)	Depth (ft)	Max. Speed (kts)	Mean Speed (kts)
32	155	44	105	3.0	0.8
106	124	36	348	2.4	0.7
198	84	22	650	1.6	0.4
300	74	18	984	1.4	0.3
410	60	15	1345	1.2	0.3
595	47	12	1952	0.9	0.2
802	48	7	2631	0.9	0.1
1000	40	6	3281	0.8	0.1
1200	50	7	3937	1.0	0.1
1400	53	9	4593	1.0	0.2
1600	52	9	5249	1.0	0.2
1800	66	10	5906	1.3	0.2
1979	68	11	6493	1.3	0.2

A normalized loop current profile (Table 3-7), 100-year loop current eddy profile (Table 3-8) and the 100-year hurricane current profile (Table 3-9), have been taken from the Deepstar JIP [Ref. 1]. The 100-year profile is associated with the seastate and wind speed provided in Table 3-4.

Table 3-7: Normalized Loop Current Profile

Depth (ft)	Speed
0	1.0
300	0.936
500	0.531
1000	0.276
1500	0.148
2000	0
6000	0

Table 3-8: 100-Year Loop Current EDDY Profile

Depth (ft)	Velocity (ft/sec)
0	6.76
300	6.25
500	2.54
1000	2.37
1500	0.85
2000	0.34
3000	0.34
6000	0

Table 3-9: 100-Year Hurricane Current Profile

Depth (ft)	Speed (ft/sec)
0	4.2
190	4.2
272	0
6000	0

3.11 Spar Model

A spar will be modeled using the AQWA computer program, based on a typical truss spar from the Gulf of Mexico. The hull and mooring properties of the modeled spar are presented in Table 3-10.

Table 3-10: Generic Spar Model Hull and Mooring Properties

Hull Configuration		
Water Depth	10000 ft	3048 m
Hull Diameter	114.8 ft	35 m
Hull length	551.2 ft	168 m
Hull draft	505 ft	154 m
Hard tank depth	195 ft	59.4 m
Hard tank centerwell width	60 ft	18.3 m
Soft tank centerwell width	60 ft	18.3 m
Free board	46.2 ft	14.1 m
Hard tank height	245 ft	74.7 m
Truss length	291 ft	88.7 m
Vertical truss member diameter	8 ft	2.4 m
Soft tank height	19 ft	5.8 m
Total Displacement	59018.9 ton (short)	53541 Te
Mooring Configuration		
Number of mooring line groups	4	
Number of mooring lines (per group)	4	
Chain size (Studless)	7 in	177.8 mm
Chain breaking strength	5269 kip	23437 kN
Fairlead chain length	250 ft	76.2 m
Bottom chain length	250 ft	76.2 m
Wire size	6.06 in	154 mm
Wire length	12000 ft	3657.6 m
Wire breaking strength	5203 kip	23145 kN
Truss Configuration		
Heave plate OD	114.8 ft	35 m
Riser configuration		
Number of SCRs	2	
Key Weight		
Topside weight in extreme condition	15086.2 ton (short)	13686 Te
Deck VCG in extreme condition (from keel)	616.8 ft	188 m
Topside weight in operation condition	15335.4 ton (short)	13912 Te
Deck VCG in operation condition (from keel)	620.1 ft	189 m

3.12 Semi-Submersible Model

A semi-submersible will be modeled using the AQWA computer program, based on a typical semi-submersible from the Gulf of Mexico. The hull and mooring properties of a semi-submersible are presented in Table 3-11. These values may be changed during the study, for a semi with a smaller displacement to better represent a typical Gulf of Mexico semi-submersible.

Table 3-11: Semi-Submersible Principal Parameters

Parameter		Value	Value
Water Depth		10,000 ft	3048 m
Overall Length		328.1 ft	100 m
Overall Width		328.1 ft	100 m
Draft		8.5 m	28 m
Displacement		130072.7 ton (short)	118,000 tonnes
COG	Longitudinal	0 ft	0 m
	Transverse	0 ft	0 m
	Vertical (above Keel)	33 ft	10.1 m
Radius of Gyration	Roll	38 ft	11.6 m
	Pitch	42 ft	12.8 m
	Yaw	46 ft	14.0 m

4. REFERENCES

1. DEEPSTAR IIA Project: “Steel Catenary Riser Performance On A Floating Production System”, DSIIA CTR A401-1, March 11th, 1996.

2. Email from Scott Moses (OSI) to Sandeep Jesudasen (INTEC), “Rotational Stiffness for a 16" Export SCR FlexJoint”, July 7th 2004.

3. Email from Alexis Lugo Fernandez (MMS) to Elizabeth Komiskey (MMS), “Profile”, April 26th 2004.

APPENDIX B

INPUT TO RELIABILITY ANALYSIS

Appendix B Contents

Note that in all cases the input data to the reliability analysis was the stress range histograms. For the cases marked with an asterisk the histogram data is excessive in volume due to the large number of seastates considered. Therefore, this appendix presents the cumulative fatigue damage along the riser, as calculated from the raw histogram data.

Stress Histograms for Fatigue Reliability Study (Semi-submersible: coupled v. uncoupled)
Full seastate scatter diagram results
Gas riser

Host Vessel: Deep Water Semi
Stress type: Wave loading induced stress
SCF 1

Number of Stress Range Cycles

				Fully Coupled Vessel (FCV) Motion (Nominal Rotational Stiffness (NRS))				Un-Coupled Vessel (UCV) Motion (Nominal Rotational Stiffness (NRS))				Un-Coupled Vessel (UCV) Motion (Aging Rotational Stiff (ARS))	
Bin #	Min Stress (MPa)	Max Stress (MPa)	Average Stress (MPa)	Critical TDP Point (LC01)	9 m Above Critical TDP Point (LC02)	End of Pipe at Hang-Off (LC03)	2.25 m Below End of Pipe at Hang-Off (LC04)	Critical TDP Point (LC05)	9 m Above Critical TDP Point (LC06)	End of Pipe at Hang-Off (LC07)	2.25 m Below End of Pipe at Hang-Off (LC08)	End of Pipe at Hang-Off (LC09)	2.25 m Below End of Pipe at Hang-Off (LC10)
1	0.0	0.5	0.25	3859041	3778341	3230466	2675640	3918640	3839750	2202721	2680360	2056296	2548488
2	0.5	1.0	0.75	1021603	1055188	982655	1191559	1044204	1071495	1214394	1194108	1191003	1211444
3	1.0	2.0	1.50	1007357	1072553	961857	1156095	1029135	1091333	1342518	1161659	1373539	1203777
4	2.0	3.0	2.50	458390	468113	446681	504432	450978	461445	566343	505381	604167	520043
5	3.0	4.0	3.50	229049	212892	252730	279813	215535	205106	305232	276530	320515	283293
6	4.0	5.0	4.50	116823	100285	152803	154930	108363	94584	169720	153474	180976	156849
7	5.0	6.0	5.50	65329	53842	91103	87863	60203	50025	94855	84269	100347	87644
8	6.0	7.0	6.50	45840	28751	62163	52679	37428	26298	56884	50548	62261	51673
9	7.0	8.0	7.50	30019	18606	39214	31174	26575	13979	33945	28400	36173	30270
10	8.0	9.0	8.50	20700	10771	27786	18730	16454	9204	21579	17046	23314	17517
11	9.0	10.0	9.50	15436	7868	19031	10265	12691	6434	12284	9858	15429	10420
12	10.0	11.0	10.50	9955	6229	13626	7113	9881	4700	8251	5880	9349	6032
13	11.0	12.0	11.50	8503	4773	9435	3824	6121	3712	4704	3288	6260	3725
14	12.0	13.0	12.50	5211	4404	6562	2333	4443	3246	2992	2172	4004	2352
15	13.0	14.0	13.50	3842	3159	5289	1712	3528	2869	2261	1513	2855	1631
16	14.0	15.0	14.50	3110	2345	3298	1066	2522	2115	1362	920	1791	1048
17	15.0	16.0	15.50	1545	2239	2327	641	1445	1413	847	653	1275	632
18	16.0	17.0	16.50	885	1348	1829	500	1432	1181	792	409	1130	563
19	17.0	18.0	17.50	656	1411	1668	334	753	906	616	321	788	378
20	18.0	19.0	18.50	459	1321	1083	286	638	737	393	243	476	289
21	19.0	20.0	19.50	455	779	828	219	576	531	329	175	554	210
22	20.0	21.0	20.50	556	422	603	152	474	332	345	150	391	150
23	21.0	22.0	21.50	473	369	494	120	255	239	187	117	340	131
24	22.0	23.0	22.50	523	282	437	104	548	471	180	95	250	111
25	23.0	24.0	23.50	350	114	314	88	299	193	169	72	240	105
26	24.0	25.0	24.50	308	167	313	68	246	149	127	68	207	84
27	25.0	26.0	25.50	245	145	214	65	332	151	116	60	160	69
28	26.0	27.0	26.50	304	121	152	54	465	161	104	50	110	52
29	27.0	28.0	27.50	306	223	167	41	458	52	68	37	164	50
30	28.0	29.0	28.50	91	116	161	36	273	170	71	33	83	41
31	29.0	30.0	29.50	192	12	78	38	459	26	57	26	97	39
32	30.0	31.0	30.50	311	94	87	24	564	97	51	27	73	30
33	31.0	32.0	31.50	183	121	53	24	262	124	65	21	84	28
34	32.0	33.0	32.50	174	72	50	21	195	92	39	18	67	24
35	33.0	34.0	33.50	130	66	57	17	69	107	32	18	44	19
36	34.0	35.0	34.50	153	110	51	19	333	167	29	13	51	17
37	35.0	36.0	35.50	140	56	52	14	227	190	32	13	37	17
38	36.0	37.0	36.50	0	89	35	11	184	64	29	11	45	16
39	37.0	38.0	37.50	0	83	27	11	113	57	21	8	40	13
40	38.0	39.0	38.50	0	48	22	9	240	55	22	6	36	9
41	39.0	40.0	39.50	0	74	25	5	106	104	16	6	29	10
42	40.0	41.0	40.50	0	55	21	7	107	33	15	6	27	8
43	41.0	42.0	41.50	0	51	20	5	0	86	17	5	20	7
44	42.0	43.0	42.50	0	16	18	4	0	114	15	5	21	6

45		43.0	44.0	43.50	0	0	14	4	0	37	11	4	18	4
46		44.0	45.0	44.50	0	0	14	5	0	74	8	5	20	4
47		45.0	46.0	45.50	0	0	16	3	0	29	10	2	11	6
48		46.0	47.0	46.50	0	0	12	3	0	51	10	3	16	4
49		47.0	48.0	47.50	0	0	10	2	0	0	9	2	12	3
50		48.0	49.0	48.50	0	0	7	3	0	0	9	2	13	4
51		49.0	50.0	49.50	0	0	9	2	0	0	7	2	10	4
52		50.0	51.0	50.50	0	0	6	2	0	0	4	2	11	2
53		51.0	52.0	51.50	0	0	6	1	0	0	4	2	8	2
54		52.0	53.0	52.50	0	0	6	1	0	0	6	1	8	2
55		53.0	54.0	53.50	0	0	8	1	0	0	5	1	8	2
56		54.0	55.0	54.50	0	0	5	1	0	0	4	1	6	2
57		55.0	56.0	55.50	0	0	4	2	0	0	4	1	7	2
58		56.0	57.0	56.50	0	0	4	1	0	0	3	1	7	1
59		57.0	58.0	57.50	0	0	3	0	0	0	3	1	5	1
60		58.0	59.0	58.50	0	0	4	1	0	0	4	1	4	1
61		59.0	60.0	59.50	0	0	3	0	0	0	3	1	4	1
62		60.0	62.0	61.00	0	0	5	1	0	0	5	1	7	2
63		62.0	64.0	63.00	0	0	5	1	0	0	5	1	8	2
64		64.0	66.0	65.00	0	0	3	1	0	0	3	1	6	1
65		66.0	68.0	67.00	0	0	5	1	0	0	3	0	5	1
66		68.0	70.0	69.00	0	0	3	0	0	0	2	0	5	1
67		70.0	72.0	71.00	0	0	3	1	0	0	2	0	4	1
68		72.0	74.0	73.00	0	0	1	0	0	0	2	0	4	0
69		74.0	76.0	75.00	0	0	2	0	0	0	2	0	3	0
70		76.0	78.0	77.00	0	0	1	0	0	0	2	0	2	0
71		78.0	80.0	79.00	0	0	2	0	0	0	2	0	3	0
72		80.0	82.0	81.00	0	0	1	0	0	0	1	0	2	0
73		82.0	84.0	83.00	0	0	1	0	0	0	1	0	1	0
74		84.0	86.0	85.00	0	0	1	0	0	0	0	0	2	0
75		86.0	88.0	87.00	0	0	1	0	0	0	1	0	2	0
76		88.0	90.0	89.00	0	0	1	0	0	0	1	0	1	0
77		90.0	92.0	91.00	0	0	1	0	0	0	0	0	1	0
78		92.0	96.0	94.00	0	0	1	0	0	0	1	0	2	0
79		96.0	98.0	97.00	0	0	0	0	0	0	0	0	1	0
80		98.0	100.0	99.00	0	0	0	0	0	0	0	0	1	0
81		100.0	105.0	102.50	0	0	1	0	0	0	0	0	1	0
82		105.0	110.0	107.50	0	0	0	0	0	0	0	0	1	0
83		110.0	115.0	112.50	0	0	0	0	0	0	0	0	1	0
84		115.0	120.0	117.50	0	0	0	0	0	0	0	0	0	0
85		120.0	125.0	122.50	0	0	0	0	0	0	0	0	0	0
86		125.0	130.0	127.50	0	0	0	0	0	0	0	0	0	0
87		130.0	135.0	132.50	0	0	0	0	0	0	0	0	0	0
88		135.0	140.0	137.50	0	0	0	0	0	0	0	0	0	0
89		140.0	145.0	142.50	0	0	0	0	0	0	0	0	0	0
90		145.0	150.0	147.50	0	0	0	0	0	0	0	0	0	0
Fatigue Life in yrs (SCF=1.0 and X" Curve):					13,317	14,852	9,377	26,131	8,679	12,010	13,795	28,912	9,081	24,358
Accumulated Damage					75.092E-6	67.331E-6	106.644E-6	38.269E-6	115.221E-6	83.264E-6	72.490E-6	34.588E-6	110.120E-6	41.054E-6
Reliability Index, β (FORM):					4.047	4.120	3.850	4.713	3.783	3.922	3.995	4.789	3.632	4.573
Probability of Failure, P_f (FORM):					25.867E-6	18.924E-6	58.988E-6	1.194E-6	77.351E-6	43.809E-6	32.345E-6	813.480E-9	140.750E-6	2.376E-6

Spar (Hard tank hang-off)
Full seastate scatter diagram results
Gas riser

Results for S-N "X'" Curve

Element	Distance	Stress Position	Fatigue Damage Stats.	Spectrum	Rainflow	Fatigue Life Stats.	Spectrum	Rainflow
1	7.710227273	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
50	733.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
56	787.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
61	814.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
65	830	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
69	842	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
71	846.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
73	850.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
75	854.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
77	858.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
79	861.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
80	862.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
81	863.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
82	865.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
83	866.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
84	867.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
85	868.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
86	870.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
87	871.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
88	872.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
89	873.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
90	874.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
91	875.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
92	876.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
93	877.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
94	878.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
95	879.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
96	880.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
97	881.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
98	882.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
99	883.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
100	884.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
101	885.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
102	886.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
103	887.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
104	888.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
105	888.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
106	889.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
107	890.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
108	891.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
109	891.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
110	892.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
111	893.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
112	894.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
113	894.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
114	895.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
115	896.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
116	897.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
117	897.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
118	898.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
119	899.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
120	900.125	1	1.07E-05	Negligible	1.00001E-05	93077.35	Infinite	99999
121	900.875	1	1.31E-05	Negligible	1.00001E-05	76512.82	Infinite	99999
122	901.625	1	1.58E-05	Negligible	1.00001E-05	63225.16	Infinite	99999
123	902.25	1	1.81E-05	Negligible	1.00001E-05	55131.9	Infinite	99999
124	902.75	1	1.99E-05	Negligible	1.00001E-05	50231.79	Infinite	99999
125	903.25	1	2.14E-05	Negligible	1.00001E-05	46687.6	Infinite	99999
126	903.75	1	2.27E-05	Negligible	1.00001E-05	44132.03	Infinite	99999
127	904.25	1	2.38E-05	Negligible	1.00001E-05	42026.68	Infinite	99999
128	904.75	1	2.47E-05	Negligible	1.00001E-05	40451.9	Infinite	99999
129	905.25	1	2.55E-05	Negligible	1.00001E-05	39209.04	Infinite	99999
130	905.75	1	2.63E-05	Negligible	1.00001E-05	38080.67	Infinite	99999
131	906.25	1	2.70E-05	Negligible	1.00001E-05	36973.46	Infinite	99999
132	906.75	1	2.78E-05	Negligible	1.00001E-05	36024.49	Infinite	99999
133	907.25	1	2.82E-05	Negligible	1.00001E-05	35407.35	Infinite	99999
134	907.75	1	2.86E-05	Negligible	1.00001E-05	34914.14	Infinite	99999
135	908.25	1	2.90E-05	Negligible	1.00001E-05	34500.37	Infinite	99999
136	908.75	1	2.90E-05	Negligible	1.00001E-05	34425.66	Infinite	99999
137	909.25	1	2.89E-05	Negligible	1.00001E-05	34588.77	Infinite	99999
138	909.75	1	2.87E-05	Negligible	1.00001E-05	34797.77	Infinite	99999
139	910.25	1	2.89E-05	Negligible	1.00001E-05	34611.24	Infinite	99999
140	910.75	1	2.89E-05	Negligible	1.00001E-05	34646.5	Infinite	99999
141	911.25	1	2.91E-05	Negligible	1.00001E-05	34322.04	Infinite	99999
142	911.75	1	2.94E-05	Negligible	1.00001E-05	33971.74	Infinite	99999
143	912.25	1	3.07E-05	Negligible	1.00001E-05	32537.48	Infinite	99999
144	912.75	1	3.20E-05	Negligible	1.00001E-05	31208.83	Infinite	99999
145	913.25	1	3.39E-05	Negligible	1.00001E-05	29511.38	Infinite	99999
146	913.75	5	3.46E-05	1.03E-05	1.02E-05	28904.27	96844.69	98030.81
147	914.25	5	3.68E-05	1.08E-05	1.06E-05	27168.34	93016.77	94502.28
148	914.75	5	3.89E-05	1.12E-05	1.10E-05	25695.11	89507.87	90818.74
149	915.25	5	4.07E-05	1.16E-05	1.15E-05	24540.18	86109.68	86992.81

150	915.75	5	4.29E-05	1.21E-05	**1.20E-05**	23333.39	82758.29	**83451.02**
151	916.25	5	4.54E-05	1.26E-05	**1.26E-05**	22031.85	79239.78	**79478.36**
152	916.75	5	4.82E-05	1.32E-05	**1.33E-05**	20750.09	75545.67	**75409.37**
153	917.25	5	5.13E-05	1.39E-05	**1.40E-05**	19483.61	71818.89	**71655.58**
154	917.75	5	5.48E-05	1.46E-05	**1.46E-05**	18262.23	68324.93	**68383.41**
155	918.25	5	5.78E-05	1.53E-05	**1.52E-05**	17286.97	65377.75	**65705.21**
156	918.75	5	6.02E-05	1.58E-05	**1.57E-05**	16608.7	63230.3	**63690.21**
157	919.25	5	6.19E-05	1.61E-05	**1.60E-05**	16146.47	61983.21	**62354.25**
158	919.75	5	6.26E-05	1.62E-05	**1.63E-05**	15969.89	61603.24	**61446.61**
159	920.25	5	6.26E-05	1.61E-05	**1.64E-05**	15975.12	61930.67	**60835.56**
160	920.75	5	6.23E-05	1.60E-05	**1.62E-05**	16045.86	62649.76	**61552.17**
161	921.25	5	6.21E-05	1.58E-05	**1.63E-05**	16112.52	63401.48	**61389.97**
162	921.75	5	6.19E-05	1.57E-05	**1.64E-05**	16167.25	63872.17	**61140.94**
163	922.25	5	6.22E-05	1.56E-05	**1.63E-05**	16067.42	63907.08	**61256.15**
164	922.75	5	6.32E-05	1.57E-05	**1.64E-05**	15834.8	63638.1	**60946.58**
165	923.25	5	6.39E-05	1.58E-05	**1.64E-05**	15643.01	63480.02	**61051.2**
166	923.75	5	6.39E-05	1.56E-05	**1.61E-05**	15648.07	63965.85	**61998.76**
167	924.25	5	6.30E-05	1.52E-05	**1.57E-05**	15873.94	65610.9	**63642.27**
168	924.75	5	6.04E-05	1.46E-05	**1.51E-05**	16555.33	68725.75	**66122.24**
169	925.25	5	5.68E-05	1.36E-05	**1.44E-05**	17591.83	73330.21	**69518.52**
170	925.75	5	5.29E-05	1.26E-05	**1.36E-05**	18891.24	79146.89	**73584.86**
171	926.25	5	4.94E-05	1.17E-05	**1.28E-05**	20244.49	85673.78	**78085.92**
172	926.75	5	4.63E-05	1.08E-05	**1.21E-05**	21582.54	92410.52	**82804.65**
173	927.25	5	4.38E-05	1.01E-05	**1.14E-05**	22853.66	99148.89	**87718.53**
174	927.75	5	4.15E-05	Negligible	**1.09E-05**	24096.97	Infinite	**91617.9**
175	928.25	5	3.87E-05	Negligible	**1.02E-05**	25813.77	Infinite	**98472.27**
176	928.75	5	3.53E-05	Negligible	**1.00001E-05**	28326.04	Infinite	**99999**
177	929.25	5	3.15E-05	Negligible	**1.00001E-05**	31746.63	Infinite	**99999**
178	929.75	5	2.77E-05	Negligible	**1.00001E-05**	36157.85	Infinite	**99999**
179	930.25	5	2.42E-05	Negligible	**1.00001E-05**	41347.01	Infinite	**99999**
180	930.75	5	2.12E-05	Negligible	**1.00001E-05**	47240.34	Infinite	**99999**
181	931.25	5	1.85E-05	Negligible	**1.00001E-05**	53916.58	Infinite	**99999**
182	931.75	5	1.62E-05	Negligible	**1.00001E-05**	61691.9	Infinite	**99999**
183	932.25	5	1.41E-05	Negligible	**1.00001E-05**	71075.32	Infinite	**99999**
184	932.75	5	1.21E-05	Negligible	**1.00001E-05**	82545.9	Infinite	**99999**
185	933.25	5	1.04E-05	Negligible	**1.00001E-05**	95927.29	Infinite	**99999**
186	933.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
187	934.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
188	934.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
189	935.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
190	935.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
191	936.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
192	936.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
193	937.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
194	937.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
195	938.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
196	938.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
197	939.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
198	939.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
199	940.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
200	940.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
201	941.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
202	941.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
203	942.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
204	942.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
205	943.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
206	943.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
207	944.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
208	944.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
209	945.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
210	945.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
211	946.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
212	946.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
213	947.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
214	947.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
215	948.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
216	948.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
217	949.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
218	949.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
219	950.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
220	950.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
221	951.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
222	951.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
223	952.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
224	952.75	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
225	953.25	5	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
226	953.75	5	1.19E-05	Negligible	**1.00001E-05**	83804.66	Infinite	**99999**
227	954.25	5	1.44E-05	Negligible	**1.00001E-05**	69293.22	Infinite	**99999**
228	954.75	5	1.73E-05	Negligible	**1.00001E-05**	57818.18	Infinite	**99999**
229	955.25	5	2.05E-05	Negligible	**1.00001E-05**	48749.38	Infinite	**99999**
230	955.75	5	2.38E-05	Negligible	**1.00001E-05**	42027.54	Infinite	**99999**
231	956.25	5	2.70E-05	Negligible	**1.00001E-05**	37050.24	Infinite	**99999**
232	956.75	5	2.98E-05	Negligible	**1.00001E-05**	33582.68	Infinite	**99999**
233	957.25	5	3.24E-05	Negligible	**1.00E-05**	30855.62	Infinite	**99531.45**

234	957.75	5	3.53E-05	Negligible	**1.08E-05**	28337.17	Infinite	**92871.44**
235	958.25	5	3.90E-05	Negligible	**1.16E-05**	25635.46	Infinite	**86177.62**
236	958.75	5	4.32E-05	Negligible	**1.26E-05**	23170.34	Infinite	**79643.3**
237	959.25	5	4.78E-05	1.00E-05	**1.35E-05**	20915.96	99965.14	**74348.78**
238	959.75	5	5.18E-05	1.09E-05	**1.43E-05**	19297.39	91623.95	**70062.62**
239	960.25	5	5.49E-05	1.17E-05	**1.49E-05**	18210.85	85775.06	**66926.05**
240	960.75	5	5.68E-05	1.22E-05	**1.54E-05**	17615.72	81961.81	**64852.69**
241	961.25	5	5.73E-05	1.26E-05	**1.58E-05**	17452.29	79435.02	**63325.58**
242	961.75	5	5.76E-05	1.29E-05	**1.60E-05**	17351.17	77302.74	**62587.8**
243	962.25	5	5.80E-05	1.34E-05	**1.61E-05**	17228.08	74811.45	**62129.54**
244	962.75	5	5.90E-05	1.40E-05	**1.62E-05**	16961.37	71670.92	**61563.76**
245	963.25	5	6.05E-05	1.47E-05	**1.64E-05**	16516.07	68158.64	**60853.02**
246	963.75	5	6.28E-05	1.54E-05	**1.66E-05**	15931.8	64816.81	**60072.63**
247	964.25	5	6.47E-05	1.61E-05	**1.68E-05**	15461.2	62143.28	**59473.23**
248	964.75	5	6.59E-05	1.65E-05	**1.71E-05**	15180.59	60443.72	**58429.49**
249	965.25	5	6.59E-05	1.67E-05	**1.71E-05**	15169.42	59837.61	**58326.56**
250	965.75	5	6.49E-05	1.66E-05	**1.70E-05**	15409.54	60309.27	**58744.32**
251	966.25	5	6.31E-05	1.62E-05	**1.67E-05**	15858.18	61727.89	**59717.77**
252	966.75	5	6.08E-05	1.57E-05	**1.63E-05**	16446.94	63852.04	**61207.11**
253	967.25	5	5.84E-05	1.51E-05	**1.58E-05**	17127.34	66409.94	**63125.33**
254	967.75	5	5.60E-05	1.45E-05	**1.53E-05**	17866.88	69138.54	**65336.49**
255	968.25	5	5.38E-05	1.39E-05	**1.47E-05**	18584.24	71857.32	**67840.05**
256	968.75	5	5.19E-05	1.34E-05	**1.42E-05**	19279.47	74525.56	**70414.88**
257	969.25	5	5.00E-05	1.29E-05	**1.37E-05**	20014.5	77229.18	**73059.22**
258	969.75	5	4.80E-05	1.25E-05	**1.32E-05**	20853.54	80110.43	**75783.17**
259	970.25	5	4.56E-05	1.20E-05	**1.27E-05**	21925.17	83302.2	**78861.3**
260	970.75	5	4.36E-05	1.15E-05	**1.22E-05**	22927.57	86863.24	**81753.21**
261	971.25	5	4.15E-05	1.10E-05	**1.19E-05**	24095.14	90789.36	**83693.26**
262	971.75	5	3.94E-05	1.05E-05	**1.15E-05**	25403.7	94909.83	**86806.28**
263	972.25	5	3.76E-05	1.01E-05	**1.11E-05**	26618.7	99006.52	**90037.4**
264	972.75	5	3.63E-05	Negligible	**1.07E-05**	27552.31	Infinite	**93287.2**
265	973.25	5	3.53E-05	Negligible	**1.04E-05**	28361	Infinite	**96195.62**
266	973.75	5	3.45E-05	Negligible	**1.01E-05**	29003.72	Infinite	**98983.86**
267	974.25	5	3.40E-05	Negligible	**1.00001E-05**	29446.55	Infinite	**99999**
268	974.75	5	3.37E-05	Negligible	**1.00001E-05**	29668.34	Infinite	**99999**
269	975.25	5	3.35E-05	Negligible	**1.00001E-05**	29846.66	Infinite	**99999**
270	975.75	5	3.30E-05	Negligible	**1.00001E-05**	30271.82	Infinite	**99999**
271	976.25	5	3.24E-05	Negligible	**1.00001E-05**	30831.54	Infinite	**99999**
272	976.75	5	3.18E-05	Negligible	**1.00001E-05**	31398.6	Infinite	**99999**
273	977.25	5	3.14E-05	Negligible	**1.00001E-05**	31837.17	Infinite	**99999**
274	977.75	5	3.11E-05	Negligible	**1.00001E-05**	32193.55	Infinite	**99999**
275	978.25	5	3.07E-05	Negligible	**1.00001E-05**	32567.06	Infinite	**99999**
276	978.75	5	3.04E-05	1.00E-05	**1.00001E-05**	32867.29	99975.58	**99999**
277	979.25	5	2.98E-05	1.01E-05	**1.00001E-05**	33526.45	99448.55	**99999**
278	979.75	5	2.95E-05	1.00E-05	**1.00001E-05**	33950.42	99691.12	**99999**
279	980.25	5	2.87E-05	Negligible	**1.00001E-05**	34900.32	Infinite	**99999**
280	980.75	5	2.83E-05	Negligible	**1.00001E-05**	35347.01	Infinite	**99999**
281	981.25	5	2.71E-05	Negligible	**1.00001E-05**	36833.29	Infinite	**99999**
282	981.75	5	2.59E-05	Negligible	**1.00001E-05**	38679.45	Infinite	**99999**
283	982.375	5	2.41E-05	Negligible	**1.00001E-05**	41512.18	Infinite	**99999**
284	983.125	5	2.18E-05	Negligible	**1.00001E-05**	45848.73	Infinite	**99999**
285	983.875	5	1.95E-05	Negligible	**1.00001E-05**	51257.62	Infinite	**99999**
286	984.625	5	1.73E-05	Negligible	**1.00001E-05**	57905.79	Infinite	**99999**
287	985.375	5	1.51E-05	Negligible	**1.00001E-05**	66138.69	Infinite	**99999**
288	986.125	5	1.35E-05	Negligible	**1.00001E-05**	74298.89	Infinite	**99999**
289	986.875	5	1.19E-05	Negligible	**1.00001E-05**	84130.76	Infinite	**99999**
290	987.625	5	1.05E-05	Negligible	**1.00001E-05**	94894	Infinite	**99999**
291	988.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
292	989.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
293	989.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
294	990.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
295	991.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
296	992.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
297	992.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
298	993.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
299	994.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
300	995.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
301	995.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
302	996.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
303	997.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
304	998.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
305	999.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
306	1000.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
307	1001.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
308	1002.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
309	1003.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
310	1004.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
311	1005.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
312	1006.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
313	1007.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
314	1008.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
315	1009.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
316	1010.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
317	1011.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**

318	1012.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
319	1013.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
320	1015.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
321	1016.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
322	1017.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
323	1018.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
324	1020.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
325	1021.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
326	1022.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
327	1023.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
328	1025.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
329	1027.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
330	1029.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
331	1031.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
332	1033.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
333	1035.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
334	1037.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
335	1039.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
336	1042	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
337	1045	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
338	1048	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
339	1051	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
340	1054	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
341	1057.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
342	1061.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
343	1065.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
344	1069.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
345	1073.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
347	1084.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
349	1096.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
351	1109.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
353	1125.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
355	1141.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
357	1164.116969	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
359	1188.939594	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
361	1213.762219	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
363	1238.584844	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
365	1263.407469	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
367	1288.230094	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
369	1313.052719	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
371	1337.875344	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
373	1362.697969	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
375	1387.520594	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
377	1412.343219	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
379	1437.165844	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
381	1461.988469	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
383	1486.811094	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
385	1511.633719	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
387	1536.456344	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
389	1561.278969	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
391	1586.101594	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
393	1610.924219	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
395	1635.746844	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
397	1660.569469	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
399	1685.392094	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
401	1710.214719	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
403	1735.037344	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
405	1759.859969	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
407	1784.682594	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
409	1809.505219	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
411	1834.327844	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
413	1859.150469	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
415	1883.973094	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
417	1908.795719	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
419	1933.618344	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
421	1963.985262	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
425	2028.415292	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
429	2092.845323	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
431	2125.060338	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
435	2189.490369	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
439	2253.9204	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
441	2286.135415	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
445	2350.565446	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
449	2414.995477	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
451	2447.210492	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
455	2511.640523	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
459	2576.070554	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
461	2608.285569	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
465	2672.7156	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
469	2737.145631	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
471	2769.360646	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
475	2833.790677	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
479	2898.220708	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
481	2930.435723	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999

485	2994.865754	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
489	3059.295785	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
491	3091.5108	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
495	3155.940831	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
499	3220.370862	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
501	3252.585877	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
505	3317.015908	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
509	3381.445938	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
511	3413.660954	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
515	3478.090985	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
519	3542.521015	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
521	3574.736031	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
525	3639.166062	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
529	3703.596092	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
531	3735.811108	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
535	3800.241138	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
539	3864.671169	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
541	3896.886185	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
545	3961.316215	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
549	4025.746246	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
551	4052.68875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
555	4103.05875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
559	4153.42875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
561	4178.61375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
565	4228.98375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
569	4279.35375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
571	4304.53875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
575	4354.90875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
579	4405.27875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
581	4430.46375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
585	4480.83375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
589	4531.20375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
591	4549.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
593	4565.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
595	4581.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
597	4597.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
599	4607.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
601	4615.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
603	4622.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
605	4626.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
607	4630.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
609	4633	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
610	4634	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
611	4635	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
612	4636	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
613	4636.8	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
614	4637.4	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
615	4638	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
616	4638.6	1	1.23E-05	1.21E-05	1.00E-05	81465.54	82317.31	99950.24
617	4639.2	1	1.57E-05	1.57E-05	1.28E-05	63738.51	63878.22	78059.1
618	4639.677273	1	1.93E-05	1.93E-05	1.58E-05	51728.04	51746.56	63366.76
619	4640.031818	1	2.28E-05	2.29E-05	1.86E-05	43884.7	43706.39	53734.67
620	4640.386364	1	2.71E-05	2.72E-05	2.22E-05	36850.11	36757.57	45110.76
621	4640.740909	1	3.23E-05	3.25E-05	2.66E-05	30961.92	30727.14	37634.27
622	4641.095455	1	3.88E-05	3.92E-05	3.21E-05	25777.37	25508.44	31177.5
623	4641.45	1	4.70E-05	4.75E-05	3.91E-05	21254.6	21034.86	25600.91
624	4641.804545	1	5.73E-05	5.79E-05	4.77E-05	17455.83	17281.31	20953.11
625	4642.159091	1	7.01E-05	7.08E-05	5.89E-05	14256.28	14115.71	16987.99
626	4642.513636	1	8.63E-05	8.72E-05	7.32E-05	11584.3	11464.63	13652.26
627	4642.868182	1	1.07E-04	1.08E-04	9.13E-05	9377.67	9258.69	10955.52
628	4643.222727	1	1.33E-04	1.34E-04	1.14E-04	7538.27	7442.02	8759.07
629	4643.525	1	1.60E-04	1.62E-04	1.39E-04	6231.3	6163.64	7202.1
630	4643.775	1	1.88E-04	1.90E-04	1.64E-04	5318.12	5259.34	6108.22
631	4644.025	1	2.21E-04	2.23E-04	1.93E-04	4533.69	4482.84	5169.86
632	4644.275	1	2.60E-04	2.62E-04	2.28E-04	3849.97	3812.41	4389.72

Spar (Hard tank hang-off)
Full seastate scatter diagram
Oil riser

Results for S-N "X'" Curve

Element	Distance	Stress Position	Fatigue Damage Stats.	Fatigue Damage Spectrum	Fatigue Damage Rainflow	Fatigue Life Stats.	Fatigue Life Spectrum	Fatigue Life Rainflow
1	7.710227273	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
50	733.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
56	787.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
61	814.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
65	830	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
69	842	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
71	846.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
73	850.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
75	854.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
77	858.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
79	861.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
80	862.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
81	863.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
82	865.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
83	866.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
84	867.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
85	868.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
86	870.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
87	871.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
88	872.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
89	873.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
90	874.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
91	875.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
92	876.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
93	877.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
94	878.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
95	879.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
96	880.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
97	881.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
98	882.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
99	883.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
100	884.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
101	885.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
102	886.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
103	887.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
104	888.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
105	888.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
106	889.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
107	890.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
108	891.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
109	891.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
110	892.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
111	893.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
112	894.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
113	894.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
114	895.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
115	896.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
116	897.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
117	897.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
118	898.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
119	899.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
120	900.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
121	900.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
122	901.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
123	902.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
124	902.75	1	1.12E-05	Negligible	**1.00001E-05**	89129.84	Infinite	**99999**
125	903.25	1	1.28E-05	Negligible	**1.00001E-05**	78355.04	Infinite	**99999**
126	903.75	1	1.45E-05	Negligible	**1.00001E-05**	68833.39	Infinite	**99999**
127	904.25	1	1.66E-05	Negligible	**1.00001E-05**	60352.43	Infinite	**99999**
128	904.75	1	1.87E-05	Negligible	**1.00001E-05**	53454.67	Infinite	**99999**
129	905.25	1	2.13E-05	Negligible	**1.00001E-05**	46910.55	Infinite	**99999**
130	905.75	1	2.41E-05	Negligible	**1.00001E-05**	41474.1	Infinite	**99999**
131	906.25	1	2.67E-05	Negligible	**1.00001E-05**	37413.51	Infinite	**99999**
132	906.75	1	2.93E-05	1.03E-05	**1.00001E-05**	34099.09	97299.06	**99999**
133	907.25	1	3.20E-05	1.11E-05	**1.00001E-05**	31237.45	90209.01	**99999**
134	907.75	1	3.41E-05	1.18E-05	**1.03E-05**	29353.32	84688.38	**96980.19**

135	908.25	1	3.61E-05	1.24E-05	**1.10E-05**	27694.02	80417.62	**91171.21**
136	908.75	1	3.79E-05	1.29E-05	**1.15E-05**	26401.81	77243.04	**87120.01**
137	909.25	1	3.92E-05	1.33E-05	**1.19E-05**	25485.07	74958.23	**83773.21**
138	909.75	1	4.05E-05	1.36E-05	**1.23E-05**	24666.72	73452.79	**81319.05**
139	910.25	1	4.17E-05	1.38E-05	**1.26E-05**	23994.34	72594	**79518.16**
140	910.75	1	4.26E-05	1.38E-05	**1.28E-05**	23481.74	72270.33	**78282.11**
141	911.25	1	4.33E-05	1.38E-05	**1.29E-05**	23099.94	72427.56	**77512.12**
142	911.75	1	4.43E-05	1.37E-05	**1.30E-05**	22579.72	73100.77	**77028.28**
143	912.25	1	4.54E-05	1.35E-05	**1.30E-05**	22028.48	73940.71	**76835.42**
144	912.75	1	4.56E-05	1.34E-05	**1.33E-05**	21950.37	74907.46	**75458.07**
145	913.25	1	4.52E-05	1.32E-05	**1.33E-05**	22142.95	75853.01	**74991.37**
146	913.75	1	4.52E-05	1.31E-05	**1.35E-05**	22123.97	76531.25	**74294.05**
147	914.25	1	4.53E-05	1.30E-05	**1.36E-05**	22094.27	76727.09	**73309.59**
148	914.75	1	4.56E-05	1.31E-05	**1.39E-05**	21906.21	76207.79	**72054.73**
149	915.25	1	4.63E-05	1.34E-05	**1.42E-05**	21581.72	74849.4	**70365.61**
150	915.75	1	4.69E-05	1.38E-05	**1.46E-05**	21322.66	72687.39	**68392.41**
151	916.25	1	4.86E-05	1.43E-05	**1.51E-05**	20565.26	69904.32	**66224.28**
152	916.75	1	5.08E-05	1.50E-05	**1.56E-05**	19678.84	66788.15	**63946.43**
153	917.25	1	5.33E-05	1.57E-05	**1.62E-05**	18759.9	63616.82	**61612.81**
154	917.75	1	5.66E-05	1.65E-05	**1.69E-05**	17675.69	60594.42	**59242.83**
155	918.25	1	5.97E-05	1.73E-05	**1.76E-05**	16746.01	57813.51	**56842.71**
156	918.75	1	6.36E-05	1.81E-05	**1.84E-05**	15716.92	55250.28	**54347.48**
157	919.25	1	6.72E-05	1.89E-05	**1.95E-05**	14874.59	52788.85	**51197.78**
158	919.75	1	7.12E-05	1.99E-05	**2.06E-05**	14046.98	50314.46	**48431.49**
159	920.25	1	7.57E-05	2.10E-05	**2.19E-05**	13210.98	47714.2	**45650.09**
160	920.75	1	8.09E-05	2.22E-05	**2.33E-05**	12361.71	44980.06	**42958.8**
161	921.25	1	8.66E-05	2.37E-05	**2.47E-05**	11545.58	42215.69	**40489.66**
162	921.75	1	9.25E-05	2.52E-05	**2.61E-05**	10812.37	39617.44	**38366.29**
163	922.25	1	9.86E-05	2.68E-05	**2.73E-05**	10138.18	37365.3	**36671.34**
164	922.75	1	1.04E-04	2.81E-05	**2.82E-05**	9610.01	35648.17	**35402.91**
165	923.25	1	1.09E-04	2.89E-05	**2.89E-05**	9197.63	34576.6	**34581.82**
166	923.75	1	1.11E-04	2.93E-05	**2.93E-05**	9043.46	34182.1	**34161.97**
167	924.25	1	1.11E-04	2.91E-05	**2.94E-05**	9042.96	34401.05	**34009.69**
168	924.75	1	1.10E-04	2.85E-05	**2.93E-05**	9074.13	35070.24	**34095.51**
169	925.25	5	1.00E-04	2.85E-05	**2.96E-05**	9991.45	35034.75	**33745.57**
170	925.75	5	9.95E-05	2.82E-05	**2.97E-05**	10054.79	35519.6	**33640.85**
171	926.25	5	9.97E-05	2.80E-05	**2.99E-05**	10035.1	35704.63	**33462.7**
172	926.75	5	1.00E-04	2.81E-05	**3.00E-05**	9961.73	35566.02	**33293.84**
173	927.25	5	1.02E-04	2.83E-05	**2.98E-05**	9833.43	35291.24	**33603.73**
174	927.75	5	1.02E-04	2.84E-05	**2.96E-05**	9776.7	35204.48	**33789.05**
175	928.25	5	1.01E-04	2.80E-05	**2.88E-05**	9881.05	35664.68	**34747.46**
176	928.75	5	9.79E-05	2.71E-05	**2.78E-05**	10216.05	36960.07	**36001.62**
177	929.25	5	9.20E-05	2.55E-05	**2.64E-05**	10869.68	39268.95	**37911.39**
178	929.75	5	8.46E-05	2.35E-05	**2.50E-05**	11819.5	42569.74	**40040.99**
179	930.25	5	7.73E-05	2.14E-05	**2.32E-05**	12939.03	46644.99	**43147.94**
180	930.75	5	7.08E-05	1.96E-05	**2.14E-05**	14125.49	51151.58	**46652.82**
181	931.25	5	6.55E-05	1.79E-05	**1.98E-05**	15269.3	55740.97	**50547.19**
182	931.75	5	6.11E-05	1.66E-05	**1.83E-05**	16370.6	60327.38	**54581.99**
183	932.25	5	5.69E-05	1.53E-05	**1.68E-05**	17562.51	65318.18	**59448.19**
184	932.75	5	5.22E-05	1.40E-05	**1.53E-05**	19152.66	71570.3	**65175.59**
185	933.25	5	4.65E-05	1.25E-05	**1.38E-05**	21484.2	80146.66	**72420.33**
186	933.75	5	4.04E-05	1.09E-05	**1.22E-05**	24735.26	91844.43	**81697.89**
187	934.25	5	3.44E-05	Negligible	**1.07E-05**	29081.86	Infinite	**93042.3**
188	934.75	5	2.91E-05	Negligible	**1.00001E-05**	34327.4	Infinite	**99999**
189	935.25	5	2.49E-05	Negligible	**1.00001E-05**	40212.21	Infinite	**99999**
190	935.75	5	2.13E-05	Negligible	**1.00001E-05**	47057.01	Infinite	**99999**
191	936.25	5	1.81E-05	Negligible	**1.00001E-05**	55375.43	Infinite	**99999**
192	936.75	5	1.53E-05	Negligible	**1.00001E-05**	65518.05	Infinite	**99999**
193	937.25	5	1.28E-05	Negligible	**1.00001E-05**	77931.48	Infinite	**99999**
194	937.75	7	1.25E-05	Negligible	**1.00001E-05**	80254.63	Infinite	**99999**
195	938.25	7	1.38E-05	Negligible	**1.00001E-05**	72272.41	Infinite	**99999**
196	938.75	7	1.55E-05	Negligible	**1.00001E-05**	64493.8	Infinite	**99999**
197	939.25	7	1.72E-05	Negligible	**1.00001E-05**	58187.28	Infinite	**99999**
198	939.75	7	1.87E-05	Negligible	**1.00001E-05**	53411.72	Infinite	**99999**
199	940.25	7	1.97E-05	Negligible	**1.00001E-05**	50856.44	Infinite	**99999**
200	940.75	7	2.08E-05	Negligible	**1.00001E-05**	48060.39	Infinite	**99999**
201	941.25	7	2.17E-05	Negligible	**1.00001E-05**	46007.62	Infinite	**99999**
202	941.75	7	2.25E-05	Negligible	**1.00001E-05**	44492.68	Infinite	**99999**
203	942.25	7	2.27E-05	1.00E-05	**1.00001E-05**	44125.4	99895.66	**99999**

204	942.75	7	2.24E-05	1.02E-05	**1.00001E-05**	44555.61	98215.31	**99999**
205	943.25	7	2.19E-05	1.02E-05	**1.00001E-05**	45632.76	98044.58	**99999**
206	943.75	7	2.10E-05	1.00E-05	**1.00001E-05**	47718.02	99835.53	**99999**
207	944.25	7	1.95E-05	Negligible	**1.00001E-05**	51337.14	Infinite	**99999**
208	944.75	7	1.76E-05	Negligible	**1.00001E-05**	56888.02	Infinite	**99999**
209	945.25	7	1.55E-05	Negligible	**1.00001E-05**	64372.68	Infinite	**99999**
210	945.75	7	1.34E-05	Negligible	**1.00001E-05**	74818.06	Infinite	**99999**
211	946.25	8	1.15E-05	Negligible	**1.00001E-05**	87003.37	Infinite	**99999**
212	946.75	8	1.02E-05	Negligible	**1.00001E-05**	98092	Infinite	**99999**
213	947.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
214	947.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
215	948.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
216	948.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
217	949.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
218	949.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
219	950.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
220	950.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
221	951.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
222	951.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
223	952.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
224	952.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
225	953.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
226	953.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
227	954.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
228	954.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
229	955.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
230	955.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
231	956.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
232	956.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
233	957.25	5	1.12E-05	Negligible	**1.00001E-05**	89320.73	Infinite	**99999**
234	957.75	5	1.41E-05	Negligible	**1.00001E-05**	70918.67	Infinite	**99999**
235	958.25	5	1.75E-05	Negligible	**1.00001E-05**	56985.19	Infinite	**99999**
236	958.75	5	2.16E-05	Negligible	**1.00001E-05**	46303.07	Infinite	**99999**
237	959.25	5	2.63E-05	Negligible	**1.00001E-05**	38003.16	Infinite	**99999**
238	959.75	5	3.17E-05	Negligible	**1.00001E-05**	31580.09	Infinite	**99999**
239	960.25	5	3.73E-05	Negligible	**1.11E-05**	26827.58	Infinite	**90072.8**
240	960.75	5	4.27E-05	1.06E-05	**1.25E-05**	23424.56	94215.61	**80032.76**
241	961.25	5	4.77E-05	1.19E-05	**1.39E-05**	20984.04	83704.52	**72172.91**
242	961.75	5	5.26E-05	1.33E-05	**1.53E-05**	18994.61	75045.97	**65487.29**
243	962.25	5	5.78E-05	1.49E-05	**1.68E-05**	17288.31	67180.57	**59509.99**
244	962.75	5	6.43E-05	1.67E-05	**1.85E-05**	15548.71	59742.13	**54012.75**
245	963.25	5	7.21E-05	1.88E-05	**2.04E-05**	13864.92	53059.48	**49132.93**
246	963.75	5	8.03E-05	2.10E-05	**2.24E-05**	12459.96	47609.38	**44584.68**
247	964.25	5	8.74E-05	2.29E-05	**2.42E-05**	11440.76	43614.87	**41370.95**
248	964.75	5	9.25E-05	2.44E-05	**2.56E-05**	10811.95	41014.56	**39071.87**
249	965.25	5	9.56E-05	2.53E-05	**2.66E-05**	10456.44	39563.2	**37588.83**
250	965.75	5	9.65E-05	2.57E-05	**2.71E-05**	10361.65	38889.44	**36925.19**
251	966.25	5	9.64E-05	2.60E-05	**2.75E-05**	10372.25	38525.42	**36334.85**
252	966.75	5	9.72E-05	2.63E-05	**2.79E-05**	10283.55	38011.37	**35854.16**
253	967.25	5	9.89E-05	2.70E-05	**2.83E-05**	10112.03	37086.21	**35331.32**
254	967.75	5	1.02E-04	2.79E-05	**2.88E-05**	9780.78	35824.42	**34671.55**
255	968.25	5	1.05E-04	2.90E-05	**3.00E-05**	9498.48	34506.6	**33293.52**
256	968.75	5	1.08E-04	2.99E-05	**3.04E-05**	9242.22	33441.48	**32904.38**
257	969.25	5	1.10E-04	3.05E-05	**3.01E-05**	9104.58	32830.61	**33200.42**
258	969.75	5	1.10E-04	3.05E-05	**3.00E-05**	9123.35	32785.93	**33321.77**
259	970.25	5	1.07E-04	3.00E-05	**2.96E-05**	9347.85	33332.75	**33751.33**
260	970.75	5	1.03E-04	2.91E-05	**2.94E-05**	9708.77	34407.65	**34001.1**
261	971.25	5	9.79E-05	2.79E-05	**2.85E-05**	10212.24	35875.18	**35103.17**
262	971.75	5	9.34E-05	2.66E-05	**2.74E-05**	10702.49	37541.09	**36491.33**
263	972.25	5	8.89E-05	2.55E-05	**2.62E-05**	11248.33	39215.32	**38188.94**
264	972.75	5	8.54E-05	2.45E-05	**2.51E-05**	11706.57	40792.27	**39904.47**
265	973.25	5	8.11E-05	2.37E-05	**2.40E-05**	12332.31	42265.98	**41672.03**
266	973.75	5	7.75E-05	2.29E-05	**2.30E-05**	12906.49	43718.99	**43444.59**
267	974.25	5	7.42E-05	2.21E-05	**2.21E-05**	13472.13	45273.21	**45217.21**
268	974.75	5	7.12E-05	2.13E-05	**2.13E-05**	14051.08	47029.98	**46893.84**
269	975.25	5	6.76E-05	2.04E-05	**2.05E-05**	14788.07	49058.02	**48669**
270	975.75	5	6.43E-05	1.95E-05	**1.97E-05**	15558.98	51356.17	**50782.59**
271	976.25	5	6.06E-05	1.86E-05	**1.90E-05**	16505.67	53868.22	**52750.44**
272	976.75	5	5.75E-05	1.77E-05	**1.83E-05**	17396.56	56364.67	**54776.13**

273	977.25	5	5.54E-05	1.70E-05	**1.76E-05**	18058.74	58692.34	**56799.2**
274	977.75	5	5.35E-05	1.65E-05	**1.69E-05**	18701.15	60651.59	**59061.66**
275	978.25	5	5.26E-05	1.61E-05	**1.64E-05**	18997.54	62119.1	**60877.03**
276	978.75	5	5.20E-05	1.59E-05	**1.59E-05**	19227.39	63049.88	**62877.2**
277	979.25	5	5.12E-05	1.58E-05	**1.56E-05**	19517.13	63490.97	**64225.07**
278	979.75	5	5.06E-05	1.57E-05	**1.53E-05**	19768.65	63549.65	**65195.71**
279	980.25	5	5.02E-05	1.58E-05	**1.52E-05**	19926.9	63357.49	**65884.76**
280	980.75	5	4.96E-05	1.59E-05	**1.52E-05**	20151.73	63054.14	**65766.05**
281	981.25	5	4.88E-05	1.59E-05	**1.58E-05**	20475.94	62738.71	**63431.8**
282	981.75	5	4.84E-05	1.60E-05	**1.57E-05**	20655.07	62471.96	**63668.94**
283	982.375	5	4.77E-05	1.60E-05	**1.56E-05**	20981.44	62549.88	**64169.61**
284	983.125	5	4.64E-05	1.59E-05	**1.54E-05**	21554.4	62916.94	**65083.25**
285	983.875	5	4.52E-05	1.56E-05	**1.49E-05**	22104.46	64274.12	**67106.61**
286	984.625	5	4.38E-05	1.50E-05	**1.43E-05**	22821.56	66700.32	**69785.5**
287	985.375	5	4.13E-05	1.41E-05	**1.36E-05**	24194.94	70737.81	**73560.98**
288	986.125	5	3.88E-05	1.31E-05	**1.29E-05**	25789.68	76062.75	**77364.73**
289	986.875	5	3.55E-05	1.21E-05	**1.19E-05**	28186.1	82729.51	**83716.01**
290	987.625	5	3.17E-05	1.10E-05	**1.10E-05**	31575.83	91222.31	**90814.12**
291	988.375	5	2.78E-05	Negligible	**1.01E-05**	35952.88	Infinite	**98877.79**
292	989.125	5	2.43E-05	Negligible	**1.00001E-05**	41069.17	Infinite	**99999**
293	989.875	5	2.11E-05	Negligible	**1.00001E-05**	47398.05	Infinite	**99999**
294	990.625	5	1.83E-05	Negligible	**1.00001E-05**	54670.63	Infinite	**99999**
295	991.375	5	1.60E-05	Negligible	**1.00001E-05**	62613.03	Infinite	**99999**
296	992.125	5	1.41E-05	Negligible	**1.00001E-05**	71123.41	Infinite	**99999**
297	992.875	5	1.26E-05	Negligible	**1.00001E-05**	79234.51	Infinite	**99999**
298	993.625	5	1.14E-05	Negligible	**1.00001E-05**	87361.88	Infinite	**99999**
299	994.375	5	1.05E-05	Negligible	**1.00001E-05**	94886.36	Infinite	**99999**
300	995.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
301	995.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
302	996.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
303	997.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
304	998.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
305	999.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
306	1000.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
307	1001.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
308	1002.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
309	1003.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
310	1004.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
311	1005.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
312	1006.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
313	1007.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
314	1008.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
315	1009.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
316	1010.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
317	1011.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
318	1012.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
319	1013.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
320	1015.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
321	1016.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
322	1017.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
323	1018.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
324	1020.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
325	1021.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
326	1022.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
327	1023.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
328	1025.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
329	1027.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
330	1029.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
331	1031.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
332	1033.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
333	1035.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
334	1037.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
335	1039.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
336	1042	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
337	1045	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
338	1048	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
339	1051	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
340	1054	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
341	1057.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**

342	1061.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
343	1065.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
344	1069.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
345	1073.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
347	1084.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
349	1096.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
351	1109.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
353	1125.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
355	1141.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
357	1164.116969	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
359	1188.939594	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
361	1213.762219	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
363	1238.584844	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
365	1263.407469	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
367	1288.230094	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
369	1313.052719	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
371	1337.875344	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
373	1362.697969	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
375	1387.520594	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
377	1412.343219	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
379	1437.165844	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
381	1461.988469	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
383	1486.811094	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
385	1511.633719	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
387	1536.456344	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
389	1561.278969	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
391	1586.101594	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
393	1610.924219	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
395	1635.746844	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
397	1660.569469	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
399	1685.392094	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
401	1710.214719	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
403	1735.037344	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
405	1759.859969	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
407	1784.682594	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
409	1809.505219	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
411	1834.327844	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
413	1859.150469	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
415	1883.973094	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
417	1908.795719	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
419	1933.618344	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
421	1963.985262	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
425	2028.415292	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
429	2092.845323	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
431	2125.060338	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
435	2189.490369	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
439	2253.9204	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
441	2286.135415	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
445	2350.565446	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
449	2414.995477	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
451	2447.210492	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
455	2511.640523	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
459	2576.070554	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
461	2608.285569	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
465	2672.7156	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
469	2737.145631	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
471	2769.360646	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
475	2833.790677	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
479	2898.220708	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
481	2930.435723	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
485	2994.865754	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
489	3059.295785	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
491	3091.5108	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
495	3155.940831	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
499	3220.370862	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
501	3252.585877	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
505	3317.015908	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
509	3381.445938	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
511	3413.660954	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**

515	3478.090985	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
519	3542.521015	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
521	3574.736031	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
525	3639.166062	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
529	3703.596092	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
531	3735.811108	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
535	3800.241138	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
539	3864.671169	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
541	3896.886185	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
545	3961.316215	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
549	4025.746246	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
551	4052.68875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
555	4103.05875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
559	4153.42875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
561	4178.61375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
565	4228.98375	1	Negligible	Negligible	**1.01E-05**	Infinite	Infinite	**98671.92**
569	4279.35375	1	1.06E-05	1.03E-05	**1.07E-05**	93989.67	97072.69	**93356.39**
571	4304.53875	1	1.09E-05	1.05E-05	**1.09E-05**	92037.66	95119.85	**91789.9**
575	4354.90875	1	1.10E-05	1.07E-05	**1.10E-05**	90692.95	93877.45	**90671.45**
579	4405.27875	1	1.08E-05	1.04E-05	**1.08E-05**	92982.72	96237.05	**92696.54**
581	4430.46375	1	1.05E-05	1.01E-05	**1.05E-05**	95362.27	98737.54	**95012.73**
585	4480.83375	5	1.03E-05	Negligible	**1.05E-05**	97527.15	Infinite	**95182.18**
589	4531.20375	5	1.17E-05	1.14E-05	**1.21E-05**	85344.75	87952.32	**82832.53**
591	4549.5	5	1.23E-05	1.19E-05	**1.27E-05**	81587.21	83969.35	**78993.05**
593	4565.5	5	1.28E-05	1.24E-05	**1.32E-05**	78432.84	80656.23	**75868.96**
595	4581.5	5	1.33E-05	1.29E-05	**1.37E-05**	75430.15	77527.32	**72887.08**
597	4597.5	5	1.38E-05	1.34E-05	**1.43E-05**	72573.77	74465.32	**69981.56**
599	4607.5	5	1.41E-05	1.37E-05	**1.46E-05**	70942.85	72729.93	**68390.03**
601	4615.5	5	1.43E-05	1.40E-05	**1.49E-05**	69742.14	71445.16	**67205.48**
603	4622.5	5	1.45E-05	1.42E-05	**1.51E-05**	68865.49	70533.38	**66430.58**
605	4626.5	5	1.45E-05	1.41E-05	**1.50E-05**	69053.36	70734.19	**66749.31**
607	4630.5	5	1.42E-05	1.39E-05	**1.46E-05**	70428.31	72120.58	**68486.02**
609	4633	5	1.39E-05	1.35E-05	**1.41E-05**	72100.74	73922.06	**71084.27**
610	4634	5	1.37E-05	1.34E-05	**1.38E-05**	72786.23	74788.47	**72429.28**
611	4635	5	1.36E-05	1.32E-05	**1.35E-05**	73536.72	75482.78	**74147.96**
612	4636	5	1.36E-05	1.32E-05	**1.32E-05**	73637.7	75680.42	**75871.03**
613	4636.8	5	1.37E-05	1.34E-05	**1.30E-05**	72809.66	74896.56	**76874.94**
614	4637.4	1	1.42E-05	1.36E-05	**1.33E-05**	70588.39	73330.29	**75339.49**
615	4638	1	1.62E-05	1.55E-05	**1.49E-05**	61779.15	64374.47	**67161.38**
616	4638.6	1	1.89E-05	1.81E-05	**1.71E-05**	52971.23	55175.17	**58556.31**
617	4639.2	1	2.27E-05	2.18E-05	**2.01E-05**	44099.61	45974.58	**49760.92**
618	4639.677273	1	2.68E-05	2.56E-05	**2.34E-05**	37344.11	39062.66	**42802.9**
619	4640.031818	1	3.07E-05	2.94E-05	**2.65E-05**	32546.7	34049.27	**37716.71**
620	4640.386364	1	3.56E-05	3.39E-05	**3.04E-05**	28057.99	29456.19	**32913.91**
621	4640.740909	1	4.17E-05	3.97E-05	**3.52E-05**	23964.6	25199.41	**28382.69**
622	4641.095455	1	4.92E-05	4.69E-05	**4.13E-05**	20310.66	21300.94	**24242.37**
623	4641.45	1	5.89E-05	5.61E-05	**4.89E-05**	16978.67	17838.67	**20435.63**
624	4641.804545	1	7.13E-05	6.77E-05	**5.90E-05**	14026.89	14782	**16940.21**
625	4642.159091	1	8.68E-05	8.25E-05	**7.18E-05**	11526.99	12115.24	**13934.01**
626	4642.513636	1	1.07E-04	1.02E-04	**8.85E-05**	9370.44	9847.13	**11298.28**
627	4642.868182	1	1.33E-04	1.26E-04	**1.10E-04**	7522.42	7944.48	**9066.13**
628	4643.222727	1	1.66E-04	1.58E-04	**1.39E-04**	6013.45	6335.34	**7183.06**
629	4643.525	1	2.02E-04	1.93E-04	**1.70E-04**	4939.98	5190.79	**5865.41**
630	4643.775	1	2.40E-04	2.28E-04	**2.03E-04**	4159.67	4386.84	**4921.86**
631	4644.025	1	2.86E-04	2.70E-04	**2.43E-04**	3490.68	3698.52	**4112.8**
632	4644.275	1	3.42E-04	3.22E-04	**2.92E-04**	2928.06	3103.54	**3422.42**

Spar (Soft tank hang-off)
Full seastate scatter diagram results
Gas riser

Results for S-N "X'" Curve

Element	Distance	Stress Position	Fatigue Damage Stats.	Spectrum	Rainflow	Fatigue Life Stats.	Spectrum	Rainflow
1	7.710227273	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
50	733.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
56	787.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
61	814.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
65	830	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
69	842	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
71	846.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
73	850.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
75	854.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
77	858.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
79	861.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
80	862.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
81	863.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
82	865.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
83	866.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
84	867.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
85	868.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
86	870.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
87	871.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
88	872.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
89	873.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
90	874.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
91	875.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
92	876.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
93	877.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
94	878.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
95	879.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
96	880.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
97	881.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
98	882.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
99	883.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
100	884.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
101	885.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
102	886.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
103	887.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
104	888.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
105	888.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
106	889.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
107	890.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
108	891.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
109	891.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
110	892.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
111	893.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
112	894.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
113	894.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
114	895.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
115	896.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
116	897.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
117	897.875	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
118	898.625	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
119	899.375	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
120	900.125	1	1.07E-05	Negligible	1.00001E-05	93077.35	Infinite	99999
121	900.875	1	1.31E-05	Negligible	1.00001E-05	76512.82	Infinite	99999
122	901.625	1	1.58E-05	Negligible	1.00001E-05	63225.16	Infinite	99999
123	902.25	1	1.81E-05	Negligible	1.00001E-05	55131.9	Infinite	99999
124	902.75	1	1.99E-05	Negligible	1.00001E-05	50231.79	Infinite	99999
125	903.25	1	1.05E-05	Negligible	1.00001E-05	95311.08	Infinite	99999
126	903.75	1	1.08E-05	Negligible	1.00001E-05	92714.65	Infinite	99999
127	904.25	1	1.12E-05	Negligible	1.00001E-05	88957.3	Infinite	99999
128	904.75	1	1.15E-05	Negligible	1.00001E-05	87130.76	Infinite	99999
129	905.25	1	1.15E-05	Negligible	1.00001E-05	87067.12	Infinite	99999
130	905.75	1	1.20E-05	Negligible	1.00001E-05	83220.94	Infinite	99999
131	906.25	1	1.20E-05	Negligible	1.00001E-05	83565.49	Infinite	99999
132	906.75	1	1.21E-05	Negligible	1.00001E-05	82675.88	Infinite	99999
133	907.25	1	1.23E-05	Negligible	1.00001E-05	81029.33	Infinite	99999
134	907.75	1	1.26E-05	Negligible	1.00001E-05	79373.63	Infinite	99999
135	908.25	1	1.32E-05	Negligible	1.00001E-05	75930.12	Infinite	99999
136	908.75	1	1.38E-05	Negligible	1.00001E-05	72339.92	Infinite	99999
137	909.25	1	1.48E-05	Negligible	1.00001E-05	67766.28	Infinite	99999
138	909.75	1	1.58E-05	Negligible	1.00001E-05	63384.76	Infinite	99999
139	910.25	1	1.66E-05	Negligible	1.00001E-05	60339.18	Infinite	99999
140	910.75	1	1.72E-05	Negligible	1.00001E-05	58274.82	Infinite	99999
141	911.25	1	1.86E-05	Negligible	1.00001E-05	53713.4	Infinite	99999
142	911.75	1	1.98E-05	Negligible	1.00001E-05	50627.9	Infinite	99999
143	912.25	1	2.10E-05	Negligible	1.00001E-05	47722.8	Infinite	99999
144	912.75	1	2.28E-05	Negligible	1.00001E-05	43838.21	Infinite	99999
145	913.25	1	2.50E-05	Negligible	1.00001E-05	40061.08	Infinite	99999
146	913.75	1	2.68E-05	Negligible	1.00001E-05	37326.34	Infinite	99999
147	914.25	1	2.84E-05	Negligible	1.00001E-05	35182.53	Infinite	99999
148	914.75	1	2.92E-05	Negligible	1.00001E-05	34258.08	Infinite	99999
149	915.25	1	3.00E-05	Negligible	1.00001E-05	33333.3	Infinite	99999

150	915.75	1	3.03E-05	Negligible	1.00001E-05	33002.96	Infinite	99999
151	916.25	1	3.02E-05	Negligible	1.00001E-05	33063.5	Infinite	99999
152	916.75	1	3.05E-05	Negligible	1.00001E-05	32839.08	Infinite	99999
153	917.25	1	3.07E-05	Negligible	1.00001E-05	32545.1	Infinite	99999
154	917.75	1	3.11E-05	Negligible	1.00001E-05	32163.93	Infinite	99999
155	918.25	1	3.16E-05	Negligible	1.00001E-05	31686.25	Infinite	99999
156	918.75	1	3.19E-05	Negligible	1.00001E-05	31367.27	Infinite	99999
157	919.25	1	3.17E-05	Negligible	1.00001E-05	31500.23	Infinite	99999
158	919.75	1	3.14E-05	Negligible	1.00001E-05	31859.64	Infinite	99999
159	920.25	1	3.01E-05	Negligible	1.00001E-05	33202.42	Infinite	99999
160	920.75	1	2.87E-05	Negligible	1.00001E-05	34845.4	Infinite	99999
161	921.25	1	2.66E-05	Negligible	1.00001E-05	37582.39	Infinite	99999
162	921.75	1	2.46E-05	Negligible	1.00001E-05	40667.64	Infinite	99999
163	922.25	5	2.29E-05	Negligible	1.00001E-05	43581.99	Infinite	99999
164	922.75	5	2.15E-05	Negligible	1.00001E-05	46450	Infinite	99999
165	923.25	5	2.01E-05	Negligible	1.00001E-05	49754.31	Infinite	99999
166	923.75	5	1.84E-05	Negligible	1.00001E-05	54402.02	Infinite	99999
167	924.25	5	1.66E-05	Negligible	1.00001E-05	60407.88	Infinite	99999
168	924.75	5	1.46E-05	Negligible	1.00001E-05	68441.51	Infinite	99999
169	925.25	5	1.27E-05	Negligible	1.00001E-05	78691.8	Infinite	99999
170	925.75	5	1.10E-05	Negligible	1.00001E-05	90563.43	Infinite	99999
171	926.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
172	926.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
173	927.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
174	927.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
175	928.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
176	928.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
177	929.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
178	929.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
179	930.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
180	930.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
181	931.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
182	931.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
183	932.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
184	932.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
185	933.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
186	933.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
187	934.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
188	934.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
189	935.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
190	935.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
191	936.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
192	936.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
193	937.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
194	937.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
195	938.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
196	938.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
197	939.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
198	939.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
199	940.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
200	940.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
201	941.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
202	941.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
203	942.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
204	942.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
205	943.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
206	943.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
207	944.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
208	944.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
209	945.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
210	945.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
211	946.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
212	946.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
213	947.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
214	947.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
215	948.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
216	948.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
217	949.25	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
218	949.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
219	950.25	5	1.08E-05	Negligible	1.00001E-05	92301.22	Infinite	99999
220	950.75	1	1.27E-05	Negligible	1.00001E-05	78624.27	Infinite	99999
221	951.25	1	1.45E-05	Negligible	1.00001E-05	68834.01	Infinite	99999
222	951.75	1	1.63E-05	Negligible	1.00001E-05	61320.36	Infinite	99999
223	952.25	1	1.82E-05	Negligible	1.00001E-05	55063.81	Infinite	99999
224	952.75	1	2.01E-05	Negligible	1.00001E-05	49682.62	Infinite	99999
225	953.25	1	2.24E-05	Negligible	1.00001E-05	44717.81	Infinite	99999
226	953.75	1	2.47E-05	Negligible	1.00001E-05	40556.37	Infinite	99999
227	954.25	1	2.68E-05	Negligible	1.00001E-05	37341.3	Infinite	99999
228	954.75	1	2.83E-05	Negligible	1.00001E-05	35307.8	Infinite	99999
229	955.25	1	2.94E-05	Negligible	1.00001E-05	33990.56	Infinite	99999
230	955.75	1	3.02E-05	Negligible	1.00001E-05	33078.76	Infinite	99999
231	956.25	1	3.01E-05	Negligible	1.00001E-05	33181.89	Infinite	99999
232	956.75	1	3.05E-05	Negligible	1.00001E-05	32765.05	Infinite	99999
233	957.25	1	3.07E-05	Negligible	1.00001E-05	32525.11	Infinite	99999

234	957.75	1	3.15E-05	Negligible	1.00001E-05	31793.79	Infinite	99999
235	958.25	1	3.23E-05	Negligible	1.00001E-05	30965.89	Infinite	99999
236	958.75	1	3.28E-05	Negligible	1.00001E-05	30457.67	Infinite	99999
237	959.25	1	3.36E-05	Negligible	1.00001E-05	29767.75	Infinite	99999
238	959.75	1	3.33E-05	Negligible	1.00001E-05	30054.56	Infinite	99999
239	960.25	1	3.33E-05	Negligible	1.00001E-05	30051.21	Infinite	99999
240	960.75	1	3.26E-05	Negligible	1.00001E-05	30713.49	Infinite	99999
241	961.25	1	3.09E-05	Negligible	1.00001E-05	32358.99	Infinite	99999
242	961.75	1	2.92E-05	Negligible	1.00001E-05	34195.58	Infinite	99999
243	962.25	1	2.76E-05	Negligible	1.00001E-05	36177.91	Infinite	99999
244	962.75	1	2.59E-05	Negligible	1.00001E-05	38622.45	Infinite	99999
245	963.25	1	2.45E-05	Negligible	1.00001E-05	40888.16	Infinite	99999
246	963.75	1	2.34E-05	Negligible	1.00001E-05	42784.35	Infinite	99999
247	964.25	1	2.23E-05	Negligible	1.00001E-05	44752.7	Infinite	99999
248	964.75	1	2.12E-05	Negligible	1.00001E-05	47154.18	Infinite	99999
249	965.25	1	2.01E-05	Negligible	1.00001E-05	49721.21	Infinite	99999
250	965.75	1	1.91E-05	Negligible	1.00001E-05	52304.61	Infinite	99999
251	966.25	1	1.79E-05	Negligible	1.00001E-05	55826.06	Infinite	99999
252	966.75	1	1.70E-05	Negligible	1.00001E-05	58970.74	Infinite	99999
253	967.25	1	1.62E-05	Negligible	1.00001E-05	61844.83	Infinite	99999
254	967.75	1	1.57E-05	Negligible	1.00001E-05	63648.8	Infinite	99999
255	968.25	1	1.56E-05	Negligible	1.00001E-05	64164.43	Infinite	99999
256	968.75	1	1.52E-05	Negligible	1.00001E-05	65578.75	Infinite	99999
257	969.25	1	1.50E-05	Negligible	1.00001E-05	66856.24	Infinite	99999
258	969.75	1	1.51E-05	Negligible	1.00001E-05	66284.91	Infinite	99999
259	970.25	1	1.51E-05	Negligible	1.00001E-05	66085.08	Infinite	99999
260	970.75	1	1.49E-05	Negligible	1.00001E-05	67015.29	Infinite	99999
261	971.25	1	1.48E-05	Negligible	1.00001E-05	67723.11	Infinite	99999
262	971.75	1	1.43E-05	Negligible	1.00001E-05	69896.33	Infinite	99999
263	972.25	1	1.42E-05	Negligible	1.00001E-05	70530.63	Infinite	99999
264	972.75	1	1.40E-05	Negligible	1.00001E-05	71581.6	Infinite	99999
265	973.25	1	1.36E-05	Negligible	1.00001E-05	73576.06	Infinite	99999
266	973.75	1	1.33E-05	Negligible	1.00001E-05	74974.79	Infinite	99999
267	974.25	1	1.27E-05	Negligible	1.00001E-05	78504.9	Infinite	99999
268	974.75	1	1.23E-05	Negligible	1.00001E-05	81372.21	Infinite	99999
269	975.25	1	1.17E-05	Negligible	1.00001E-05	85224.37	Infinite	99999
270	975.75	1	1.10E-05	Negligible	1.00001E-05	91125.3	Infinite	99999
271	976.25	1	1.02E-05	Negligible	1.00001E-05	97756.3	Infinite	99999
272	976.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
273	977.25	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
274	977.75	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
275	978.25	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
276	978.75	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
277	979.25	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
278	979.75	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
279	980.25	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
280	980.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
281	981.25	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
282	981.75	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
283	982.375	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
284	983.125	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
285	983.875	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
286	984.625	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
287	985.375	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
288	986.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
289	986.875	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
290	987.625	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
291	988.375	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
292	989.125	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
293	989.875	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
294	990.625	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
295	991.375	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
296	992.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
297	992.875	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
298	993.625	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
299	994.375	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
300	995.125	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
301	995.875	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
302	996.625	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
303	997.5	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
304	998.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
305	999.5	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
306	1000.5	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
307	1001.5	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
308	1002.5	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
309	1003.5	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
310	1004.5	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
311	1005.5	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
312	1006.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
313	1007.5	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
314	1008.5	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
315	1009.5	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
316	1010.5	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
317	1011.5	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999

318	1012.625	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
319	1013.875	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
320	1015.125	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
321	1016.375	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
322	1017.625	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
323	1018.875	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
324	1020.125	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
325	1021.375	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
326	1022.625	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
327	1023.875	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
328	1025.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
329	1027.5	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
330	1029.5	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
331	1031.5	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
332	1033.5	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
333	1035.5	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
334	1037.5	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
335	1039.5	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
336	1042	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
337	1045	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
338	1048	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
339	1051	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
340	1054	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
341	1057.5	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
342	1061.5	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
343	1065.5	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
344	1069.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
345	1073.5	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
347	1084.5	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
349	1096.5	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
351	1109.5	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
353	1125.5	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
355	1141.5	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
357	1164.116969	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
359	1188.939594	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
361	1213.762219	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
363	1238.584844	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
365	1263.407469	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
367	1288.230094	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
369	1313.052719	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
371	1337.875344	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
373	1362.697969	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
375	1387.520594	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
377	1412.343219	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
379	1437.165844	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
381	1461.988469	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
383	1486.811094	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
385	1511.633719	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
387	1536.456344	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
389	1561.278969	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
391	1586.101594	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
393	1610.924219	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
395	1635.746844	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
397	1660.569469	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
399	1685.392094	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
401	1710.214719	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
403	1735.037344	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
405	1759.859969	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
407	1784.682594	7	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
409	1809.505219	8	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
411	1834.327844	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
413	1859.150469	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
415	1883.973094	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
417	1908.795719	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
419	1933.618344	5	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
421	1963.985262	6	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
425	2028.415292	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
429	2092.845323	2	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
431	2125.060338	3	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
435	2189.490369	4	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
439	2253.9204	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
441	2286.135415	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
445	2350.565446	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
449	2414.995477	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
451	2447.210492	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
455	2511.640523	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
459	2576.070554	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
461	2608.285569	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
465	2672.7156	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
469	2737.145631	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
471	2769.360646	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
475	2833.790677	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
479	2898.220708	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
481	2930.435723	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999

485	2994.865754	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
489	3059.295785	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
491	3091.5108	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
495	3155.940831	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
499	3220.370862	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
501	3252.585877	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
505	3317.015908	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
509	3381.445938	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
511	3413.660954	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
515	3478.090985	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
519	3542.521015	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
521	3574.736031	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
525	3639.166062	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
529	3703.596092	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
531	3735.811108	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
535	3800.241138	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
539	3864.671169	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
541	3896.886185	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
545	3961.316215	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
549	4025.746246	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
551	4052.68875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
555	4103.05875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
559	4153.42875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
561	4178.61375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
565	4228.98375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
569	4279.35375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
571	4304.53875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
575	4354.90875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
579	4405.27875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
581	4430.46375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
585	4480.83375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
589	4531.20375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
591	4549.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
593	4565.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
595	4581.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
597	4597.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
599	4607.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
601	4615.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
603	4622.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
605	4626.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
607	4630.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
609	4633	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
610	4634	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
611	4635	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
612	4636	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
613	4636.8	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
614	4637.4	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
615	4638	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
616	4638.6	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
617	4639.2	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
618	4639.677273	1	1.09E-05	1.11E-05	**1.00001E-05**	92069.56	90385.7	**99999**
619	4640.031818	1	1.33E-05	1.36E-05	**1.18E-05**	74929.55	73543.72	**84559.66**
620	4640.386364	1	1.65E-05	1.67E-05	**1.47E-05**	60640.1	59704.17	**68116.34**
621	4640.740909	1	2.03E-05	2.06E-05	**1.83E-05**	49257.88	48429.08	**54607.6**
622	4641.095455	1	2.52E-05	2.56E-05	**2.29E-05**	39693.67	39006.75	**43701.37**
623	4641.45	1	3.12E-05	3.19E-05	**2.90E-05**	32009.3	31352.84	**34511.59**
624	4641.804545	1	3.91E-05	3.99E-05	**3.66E-05**	25596.13	25068.65	**27301.92**
625	4642.159091	1	4.90E-05	5.00E-05	**4.67E-05**	20392.58	20018.82	**21428.8**
626	4642.513636	1	6.14E-05	6.27E-05	**5.91E-05**	16286.8	15938.01	**16930.55**
627	4642.868182	1	7.75E-05	7.91E-05	**7.54E-05**	12900.28	12645.37	**13262.08**
628	4643.222727	1	9.79E-05	1.00E-04	**9.74E-05**	10218.87	9984.42	**10265.27**
629	4643.525	1	1.19E-04	1.22E-04	**1.20E-04**	8377.28	8187.71	**8304.67**
630	4643.775	1	1.41E-04	1.45E-04	**1.44E-04**	7068.98	6914.04	**6958.87**
631	4644.025	1	1.67E-04	1.72E-04	**1.71E-04**	5972.51	5823.25	**5840.66**
632	4644.275	1	1.99E-04	2.04E-04	**2.05E-04**	5027.7	4903.77	**4881.46**

Spar (Soft tank hang-off)
Full seastate scatter diagram results
Oil riser

Results for S-N "X'" Curve

Element	Distance	Stress Position	Fatigue Damage Stats.	Spectrum	Rainflow	Fatigue Life Stats.	Spectrum	Rainflow
1	7.677884615	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
50	760.1105769	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
56	833.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
61	883.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
65	913.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
69	934.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
71	942.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
73	950	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
75	956	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
77	962	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
79	966.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
80	968.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
81	970.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
82	972.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
83	974.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
84	976.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
85	978.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
86	980.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
87	981.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
88	982.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
89	983.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
90	985.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
91	986.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
92	987.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
93	988.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
94	990.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
95	991.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
96	992.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
97	993.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
98	994.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
99	995.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
100	996.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
101	997.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
102	998.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
103	999.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
104	1000.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
105	1001.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
106	1002.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
107	1003.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
108	1004.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
109	1005.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
110	1006.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
111	1007.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
112	1008.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
113	1008.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
114	1009.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
115	1010.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
116	1011.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
117	1011.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
118	1012.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
119	1013.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
120	1014.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
121	1014.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
122	1015.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
123	1016.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
124	1017.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
125	1017.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
126	1018.625	1	1.13E-05	Negligible	**1.00001E-05**	88328.82	Infinite	**99999**
127	1019.375	1	1.31E-05	Negligible	**1.00001E-05**	76120.34	Infinite	**99999**
128	1020.125	1	1.45E-05	Negligible	**1.00001E-05**	69040.89	Infinite	**99999**
129	1020.875	1	1.64E-05	Negligible	**1.00001E-05**	61025.96	Infinite	**99999**
130	1021.625	1	1.77E-05	Negligible	**1.00001E-05**	56460.92	Infinite	**99999**
131	1022.25	1	1.87E-05	Negligible	**1.00001E-05**	53483.66	Infinite	**99999**
132	1022.75	1	1.96E-05	Negligible	**1.00001E-05**	50906.05	Infinite	**99999**
133	1023.25	1	2.03E-05	Negligible	**1.00001E-05**	49368.94	Infinite	**99999**
134	1023.75	1	2.05E-05	Negligible	**1.00001E-05**	48701.35	Infinite	**99999**

135	1024.25	1	2.07E-05	Negligible	**1.00001E-05**	48296.14	Infinite	**99999**
136	1024.75	1	2.06E-05	Negligible	**1.00001E-05**	48618.87	Infinite	**99999**
137	1025.25	1	2.05E-05	Negligible	**1.00001E-05**	48820.34	Infinite	**99999**
138	1025.75	1	2.06E-05	Negligible	**1.00001E-05**	48592.72	Infinite	**99999**
139	1026.25	1	2.09E-05	Negligible	**1.00001E-05**	47747.36	Infinite	**99999**
140	1026.75	1	2.09E-05	Negligible	**1.00001E-05**	47773.02	Infinite	**99999**
141	1027.25	1	2.12E-05	Negligible	**1.00001E-05**	47146.12	Infinite	**99999**
142	1027.75	1	2.18E-05	Negligible	**1.00001E-05**	45938.99	Infinite	**99999**
143	1028.25	1	2.26E-05	Negligible	**1.00001E-05**	44201.81	Infinite	**99999**
144	1028.75	1	2.37E-05	Negligible	**1.00001E-05**	42167.02	Infinite	**99999**
145	1029.25	1	2.49E-05	Negligible	**1.00001E-05**	40175.65	Infinite	**99999**
146	1029.75	1	2.66E-05	Negligible	**1.00001E-05**	37541.27	Infinite	**99999**
147	1030.25	1	2.87E-05	Negligible	**1.00001E-05**	34805.74	Infinite	**99999**
148	1030.75	1	3.14E-05	Negligible	**1.00001E-05**	31853.45	Infinite	**99999**
149	1031.25	1	3.38E-05	Negligible	**1.00001E-05**	29555.76	Infinite	**99999**
150	1031.75	1	3.62E-05	1.05E-05	**1.00001E-05**	27603.45	95238.41	**99999**
151	1032.25	1	3.90E-05	1.13E-05	**1.07E-05**	25626.95	88135.33	**93615.01**
152	1032.75	1	4.17E-05	1.23E-05	**1.16E-05**	23959.55	81113.15	**85913.68**
153	1033.25	1	4.45E-05	1.34E-05	**1.27E-05**	22470.56	74398.63	**78992.62**
154	1033.75	1	4.83E-05	1.46E-05	**1.37E-05**	20703.94	68328.03	**73044.82**
155	1034.25	1	5.17E-05	1.58E-05	**1.46E-05**	19348.06	63163.11	**68338.58**
156	1034.75	1	5.37E-05	1.69E-05	**1.55E-05**	18634.02	59068.25	**64321.83**
157	1035.25	1	5.62E-05	1.78E-05	**1.64E-05**	17785.89	56100.87	**61115.61**
158	1035.75	1	5.78E-05	1.85E-05	**1.71E-05**	17310.33	54135.69	**58539.88**
159	1036.25	1	5.84E-05	1.89E-05	**1.77E-05**	17125.91	52931.18	**56393.72**
160	1036.75	1	5.89E-05	1.92E-05	**1.84E-05**	16980.41	52156.59	**54405.72**
161	1037.25	1	5.90E-05	1.94E-05	**1.90E-05**	16952.75	51467.46	**52666.22**
162	1037.75	1	5.99E-05	1.98E-05	**1.96E-05**	16707.52	50631.3	**50989.57**
163	1038.25	1	6.08E-05	2.02E-05	**2.01E-05**	16437.93	49605.05	**49694.73**
164	1038.75	1	6.22E-05	2.06E-05	**2.05E-05**	16086.6	48616.53	**48685.82**
165	1039.25	1	6.26E-05	2.09E-05	**2.07E-05**	15974.68	47949.52	**48287.29**
166	1039.75	1	6.20E-05	2.08E-05	**2.06E-05**	16126.15	48065.08	**48662.67**
167	1040.25	1	5.99E-05	2.03E-05	**2.00E-05**	16697.57	49304.04	**49996.03**
168	1040.75	1	5.72E-05	1.93E-05	**1.92E-05**	17475.43	51856.47	**52055.12**
169	1041.25	1	5.30E-05	1.79E-05	**1.82E-05**	18867.3	55730.46	**54983.99**
170	1041.75	1	4.88E-05	1.65E-05	**1.70E-05**	20491.42	60717.21	**58666.95**
171	1042.25	1	4.48E-05	1.50E-05	**1.59E-05**	22305.61	66451.97	**63026.14**
172	1042.75	1	4.14E-05	1.38E-05	**1.47E-05**	24141.05	72615.77	**67997.39**
173	1043.25	1	3.82E-05	1.26E-05	**1.36E-05**	26201.22	79219.94	**73746.85**
174	1043.75	1	3.50E-05	1.15E-05	**1.24E-05**	28595.74	86955.68	**80878.22**
175	1044.25	1	3.15E-05	1.03E-05	**1.10E-05**	31746.17	97223	**90694.45**
176	1044.75	1	2.76E-05	Negligible	**1.00001E-05**	36251.86	Infinite	**99999**
177	1045.25	1	2.34E-05	Negligible	**1.00001E-05**	42821.54	Infinite	**99999**
178	1045.75	1	1.96E-05	Negligible	**1.00001E-05**	50931.76	Infinite	**99999**
179	1046.25	1	1.63E-05	Negligible	**1.00001E-05**	61436.79	Infinite	**99999**
180	1046.75	5	1.37E-05	Negligible	**1.00001E-05**	73175.27	Infinite	**99999**
181	1047.25	5	1.15E-05	Negligible	**1.00001E-05**	87289.9	Infinite	**99999**
182	1047.75	3	1.21E-05	Negligible	**1.00001E-05**	82420.75	Infinite	**99999**
183	1048.25	7	1.41E-05	Negligible	**1.00001E-05**	70699.06	Infinite	**99999**
184	1048.75	7	1.61E-05	Negligible	**1.00001E-05**	62300.95	Infinite	**99999**
185	1049.25	7	1.76E-05	Negligible	**1.00001E-05**	56676.12	Infinite	**99999**
186	1049.75	7	1.76E-05	Negligible	**1.00001E-05**	56689.99	Infinite	**99999**
187	1050.25	7	1.80E-05	Negligible	**1.00001E-05**	55580.19	Infinite	**99999**
188	1050.75	7	1.84E-05	Negligible	**1.00001E-05**	54399.68	Infinite	**99999**
189	1051.25	7	1.80E-05	Negligible	**1.00001E-05**	55548.44	Infinite	**99999**
190	1051.75	7	1.78E-05	Negligible	**1.00001E-05**	56158.26	Infinite	**99999**
191	1052.25	7	1.71E-05	Negligible	**1.00001E-05**	58394.21	Infinite	**99999**
192	1052.75	7	1.68E-05	Negligible	**1.00001E-05**	59502.38	Infinite	**99999**
193	1053.25	7	1.64E-05	Negligible	**1.00001E-05**	60913.34	Infinite	**99999**
194	1053.75	7	1.61E-05	Negligible	**1.00001E-05**	62243.5	Infinite	**99999**
195	1054.25	7	1.57E-05	Negligible	**1.00001E-05**	63891.62	Infinite	**99999**
196	1054.75	7	1.47E-05	Negligible	**1.00001E-05**	67908.1	Infinite	**99999**
197	1055.25	7	1.36E-05	Negligible	**1.00001E-05**	73680.68	Infinite	**99999**
198	1055.75	7	1.14E-05	Negligible	**1.00001E-05**	87786.59	Infinite	**99999**
199	1056.25	7	1.14E-05	Negligible	**1.00001E-05**	87786.59	Infinite	**99999**
200	1056.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
201	1057.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
202	1057.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
203	1058.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**

204	1058.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
205	1059.25	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
206	1059.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
207	1060.25	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
208	1060.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
209	1061.25	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
210	1061.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
211	1062.25	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
212	1062.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
213	1063.25	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
214	1063.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
215	1064.25	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
216	1064.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
217	1065.25	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
218	1065.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
219	1066.25	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
220	1066.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
221	1067.25	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
222	1067.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
223	1068.25	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
224	1068.75	1	Negligible	Negligible	1.00001E-05	Infinite	Infinite	99999
225	1069.25	1	1.19E-05	Negligible	1.00001E-05	83769.35	Infinite	99999
226	1069.75	1	1.51E-05	Negligible	1.00001E-05	66171.72	Infinite	99999
227	1070.25	1	1.87E-05	Negligible	1.00001E-05	53436.04	Infinite	99999
228	1070.75	1	2.27E-05	Negligible	1.00001E-05	44126.35	Infinite	99999
229	1071.25	1	2.65E-05	Negligible	1.00001E-05	37753.61	Infinite	99999
230	1071.75	1	3.01E-05	Negligible	1.00001E-05	33232.88	Infinite	99999
231	1072.25	1	3.38E-05	1.13E-05	1.10E-05	29579.36	88535.41	90750.39
232	1072.75	1	3.74E-05	1.28E-05	1.22E-05	26738.22	78320.83	82141.86
233	1073.25	1	4.15E-05	1.45E-05	1.34E-05	24121.96	69201.64	74408.02
234	1073.75	1	4.70E-05	1.64E-05	1.48E-05	21290.63	61033.54	67656.72
235	1074.25	1	5.23E-05	1.84E-05	1.62E-05	19124.99	54240.76	61887.02
236	1074.75	1	5.67E-05	2.03E-05	1.74E-05	17627.31	49169.68	57338.85
237	1075.25	1	6.05E-05	2.18E-05	1.86E-05	16525.35	45857.95	53675.05
238	1075.75	1	6.36E-05	2.27E-05	1.94E-05	15719.57	44134.03	51636.39
239	1076.25	1	6.40E-05	2.29E-05	2.00E-05	15622.02	43662.03	49962.46
240	1076.75	1	6.44E-05	2.27E-05	2.02E-05	15521.66	44003.02	49432.5
241	1077.25	1	6.43E-05	2.24E-05	2.04E-05	15561.74	44651.29	49025.23
242	1077.75	1	6.41E-05	2.21E-05	2.03E-05	15611.36	45171.45	49302.79
243	1078.25	1	6.35E-05	2.20E-05	2.01E-05	15748.88	45380.39	49726.65
244	1078.75	1	6.45E-05	2.20E-05	1.99E-05	15497.5	45384.44	50341.41
245	1079.25	1	6.51E-05	2.20E-05	1.96E-05	15364.46	45487.45	50957.83
246	1079.75	1	6.52E-05	2.17E-05	1.93E-05	15329	45996.3	51781.22
247	1080.25	1	6.38E-05	2.12E-05	1.89E-05	15684.21	47160.82	52963.07
248	1080.75	1	6.20E-05	2.04E-05	1.83E-05	16138.81	49099.69	54644.45
249	1081.25	1	5.86E-05	1.93E-05	1.76E-05	17057.9	51835.64	56818.64
250	1081.75	1	5.54E-05	1.81E-05	1.67E-05	18065.8	55251.89	59715.11
251	1082.25	1	5.29E-05	1.69E-05	1.60E-05	18915.19	59150.21	62492.17
252	1082.75	1	4.98E-05	1.58E-05	1.50E-05	20073.98	63307.24	66775.27
253	1083.25	1	4.66E-05	1.48E-05	1.39E-05	21445.41	67572.98	71778.8
254	1083.75	1	4.39E-05	1.39E-05	1.30E-05	22797.25	71930.98	76724.24
255	1084.25	1	4.13E-05	1.31E-05	1.22E-05	24202.75	76501.74	81983.68
256	1084.75	1	3.88E-05	1.23E-05	1.14E-05	25790.6	81364.77	88070.63
257	1085.25	1	3.64E-05	1.15E-05	1.05E-05	27459.42	86705.35	94999.13
258	1085.75	1	3.42E-05	1.08E-05	1.00001E-05	29219.64	92622.83	99999
259	1086.25	1	3.17E-05	1.01E-05	1.00001E-05	31550.89	99194.13	99999
260	1086.75	1	3.02E-05	Negligible	1.00001E-05	33146.49	Infinite	99999
261	1087.25	1	2.83E-05	Negligible	1.00001E-05	35309.7	Infinite	99999
262	1087.75	1	2.70E-05	Negligible	1.00001E-05	37066	Infinite	99999
263	1088.25	1	2.63E-05	Negligible	1.00001E-05	38021.68	Infinite	99999
264	1088.75	1	2.53E-05	Negligible	1.00001E-05	39560.37	Infinite	99999
265	1089.25	1	2.48E-05	Negligible	1.00001E-05	40297.81	Infinite	99999
266	1089.75	1	2.49E-05	Negligible	1.00001E-05	40222.88	Infinite	99999
267	1090.25	1	2.49E-05	Negligible	1.00001E-05	40174.36	Infinite	99999
268	1090.75	1	2.50E-05	Negligible	1.00001E-05	40076.1	Infinite	99999
269	1091.25	1	2.46E-05	Negligible	1.00001E-05	40570.71	Infinite	99999
270	1091.75	1	2.45E-05	Negligible	1.00001E-05	40751.72	Infinite	99999
271	1092.25	1	2.42E-05	Negligible	1.00001E-05	41308.57	Infinite	99999
272	1092.75	1	2.43E-05	Negligible	1.00001E-05	41180.96	Infinite	99999

273	1093.25	1	2.38E-05	Negligible	**1.00001E-05**	41967.17	Infinite	**99999**
274	1093.75	1	2.34E-05	Negligible	**1.00001E-05**	42736.52	Infinite	**99999**
275	1094.25	1	2.26E-05	Negligible	**1.00001E-05**	44326.1	Infinite	**99999**
276	1094.75	1	2.19E-05	Negligible	**1.00001E-05**	45683.57	Infinite	**99999**
277	1095.25	1	2.13E-05	Negligible	**1.00001E-05**	46910.36	Infinite	**99999**
278	1095.75	1	2.02E-05	Negligible	**1.00001E-05**	49523.1	Infinite	**99999**
279	1096.25	1	1.87E-05	Negligible	**1.00001E-05**	53524.07	Infinite	**99999**
280	1096.75	1	1.71E-05	Negligible	**1.00001E-05**	58413.13	Infinite	**99999**
281	1097.25	1	1.56E-05	Negligible	**1.00001E-05**	63937.86	Infinite	**99999**
282	1097.75	1	1.41E-05	Negligible	**1.00001E-05**	70979.85	Infinite	**99999**
283	1098.25	1	1.26E-05	Negligible	**1.00001E-05**	79336.93	Infinite	**99999**
284	1098.75	1	1.13E-05	Negligible	**1.00001E-05**	88124.56	Infinite	**99999**
285	1099.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
286	1099.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
287	1100.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
288	1100.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
289	1101.25	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
290	1101.75	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
291	1102.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
292	1103.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
293	1103.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
294	1104.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
295	1105.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
296	1106.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
297	1106.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
298	1107.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
299	1108.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
300	1109.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
301	1109.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
302	1110.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
303	1111.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
304	1112.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
305	1112.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
306	1113.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
307	1114.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
308	1115.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
309	1115.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
310	1116.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
311	1117.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
312	1118.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
313	1119.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
314	1120.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
315	1121.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
316	1122.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
317	1123.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
318	1124.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
319	1125.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
320	1126.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
321	1127.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
322	1128.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
323	1129.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
324	1130.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
325	1131.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
326	1132.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
327	1133.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
328	1135.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
329	1136.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
330	1137.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
331	1138.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
332	1140.125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
333	1141.375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
334	1142.625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
335	1143.875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
336	1145.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
337	1147.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
338	1149.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
339	1151.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
340	1153.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
341	1155.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**

342	1157.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
343	1159.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
344	1162	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
345	1165	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
347	1171	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
349	1176.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
351	1184.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
353	1192.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
355	1204.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
357	1216.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
359	1229.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
361	1245.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
363	1261.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
365	1283.56225	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
367	1307.64525	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
369	1331.72825	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
371	1355.81125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
373	1379.89425	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
375	1403.97725	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
377	1428.06025	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
379	1452.14325	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
381	1476.22625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
383	1500.30925	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
385	1524.39225	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
387	1548.47525	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
389	1572.55825	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
391	1596.64125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
393	1620.72425	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
395	1644.80725	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
397	1668.89025	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
399	1692.97325	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
401	1717.05625	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
403	1741.13925	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
405	1765.22225	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
407	1789.30525	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
409	1813.38825	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
411	1837.47125	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
413	1861.55425	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
415	1885.63725	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
417	1909.72025	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
419	1933.80325	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
421	1963.985262	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
425	2028.415292	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
429	2092.845323	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
431	2125.060338	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
435	2189.490369	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
439	2253.9204	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
441	2286.135415	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
445	2350.565446	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
449	2414.995477	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
451	2447.210492	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
455	2511.640523	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
459	2576.070554	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
461	2608.285569	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
465	2672.7156	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
469	2737.145631	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
471	2769.360646	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
475	2833.790677	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
479	2898.220708	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
481	2930.435723	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
485	2994.865754	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
489	3059.295785	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
491	3091.5108	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
495	3155.940831	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
499	3220.370862	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
501	3252.585877	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
505	3317.015908	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
509	3381.445938	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
511	3413.660954	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**

515	3478.090985	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
519	3542.521015	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
521	3574.736031	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
525	3639.166062	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
529	3703.596092	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
531	3735.811108	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
535	3800.241138	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
539	3864.671169	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
541	3896.886185	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
545	3961.316215	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
549	4025.746246	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
551	4052.68875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
555	4103.05875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
559	4153.42875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
561	4178.61375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
565	4228.98375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
569	4279.35375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
571	4304.53875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
575	4354.90875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
579	4405.27875	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
581	4430.46375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
585	4480.83375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
589	4531.20375	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
591	4549.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
593	4565.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
595	4581.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
597	4597.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
599	4607.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
601	4615.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
603	4622.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
605	4626.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
607	4630.5	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
609	4633	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
610	4634	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
611	4635	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
612	4636	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
613	4636.8	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
614	4637.4	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
615	4638	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
616	4638.6	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
617	4639.2	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
618	4639.677273	1	Negligible	Negligible	**1.00001E-05**	Infinite	Infinite	**99999**
619	4640.031818	1	1.10E-05	1.05E-05	**1.00001E-05**	91013.24	94916.53	**99999**
620	4640.386364	1	1.36E-05	1.30E-05	**1.15E-05**	73437.61	76873.99	**86632.1**
621	4640.740909	1	1.70E-05	1.62E-05	**1.45E-05**	58933.34	61594.71	**69097.95**
622	4641.095455	1	2.14E-05	2.04E-05	**1.83E-05**	46742.26	49118.29	**54538.25**
623	4641.45	1	2.72E-05	2.57E-05	**2.33E-05**	36824.89	38909.12	**42858.31**
624	4641.804545	1	3.45E-05	3.26E-05	**3.01E-05**	29022.95	30642.76	**33237.44**
625	4642.159091	1	4.41E-05	4.18E-05	**3.89E-05**	22669.97	23926.68	**25706.61**
626	4642.513636	1	5.69E-05	5.38E-05	**5.08E-05**	17575.4	18597.85	**19668.09**
627	4642.868182	1	7.39E-05	6.96E-05	**6.68E-05**	13535.47	14369.15	**14975.87**
628	4643.222727	1	9.63E-05	9.03E-05	**8.91E-05**	10383.16	11070.77	**11228.63**
629	4643.525	1	1.21E-04	1.14E-04	**1.13E-04**	8247.32	8809.23	**8834.15**
630	4643.775	1	1.47E-04	1.38E-04	**1.39E-04**	6786.94	7269.97	**7203**
631	4644.025	1	1.78E-04	1.67E-04	**1.71E-04**	5611.21	5982.11	**5863.07**
632	4644.275	1	2.17E-04	2.04E-04	**2.10E-04**	4607.24	4906.23	**4759.98**

Seabed trenching sensitivity
Representative seastate results
Oil riser

			Conventional Model						Carisima Trench Model					
			Sea State Near 7		Sea State Far 7		Sea State Cross 7		Sea State Near 7		Sea State Far 7		Sea State Cross 7	
Bin #	Stress Range (Mpa)	Equivalent Range (Mpa)	No. of Cycles	Damage (1/yr)	No. of Cycles	Damage (1/yr)	No. of Cycles	Damage (1/yr)	No. of Cycles	Damage (1/yr)	No. of Cycles	Damage (1/yr)	No. of Cycles	Damage (1/yr)
1	0.000 - 0.500	0.25	333108	5.00E-09	420768	6.32E-09	1534050	2.30E-08	315576	4.74E-09	1279836	1.92E-08	9300726	1.40E-07
2	0.500 - 1.000	0.75	131490	5.33E-08	87660	3.56E-08	841536	3.41E-07	166554	6.76E-08	341874	1.39E-07	2016180	8.18E-07
3	1.000 - 2.000	1.5	262980	8.53E-07	184086	5.97E-07	2585970	8.39E-06	289278	9.39E-07	359406	1.17E-06	2182734	7.08E-06
4	2.000 - 3.000	2.5	298044	4.48E-06	341874	5.14E-06	1858392	2.79E-05	350640	5.27E-06	517194	7.77E-06	1139580	1.71E-05
5	3.000 - 4.000	3.5	376938	1.55E-05	350640	1.45E-05	517194	2.13E-05	464598	1.92E-05	666216	2.75E-05	674982	2.78E-05
6	4.000 - 5.000	4.5	341874	3.00E-05	508428	4.45E-05	78894	6.91E-06	473364	4.15E-05	710046	6.22E-05	631152	5.53E-05
7	5.000 - 6.000	5.5	552258	8.83E-05	403236	6.45E-05	0	0.00E+00	534726	8.55E-05	604854	9.68E-05	525960	8.41E-05
8	6.000 - 7.000	6.5	412002	1.09E-04	499662	1.32E-04	0	0.00E+00	490896	1.30E-04	718812	1.90E-04	368172	9.72E-05
9	7.000 - 8.000	7.5	429534	1.74E-04	447066	1.81E-04	0	0.00E+00	534726	2.17E-04	517194	2.10E-04	262980	1.07E-04
10	8.000 - 9.000	8.5	394470	2.33E-04	376938	2.23E-04	0	0.00E+00	429534	2.54E-04	359406	2.12E-04	192852	1.14E-04
11	9.000 - 10.000	9.5	385704	3.18E-04	447066	3.69E-04	0	0.00E+00	420768	3.47E-04	271746	2.24E-04	87660	7.23E-05
12	10.000 - 11.000	10.5	368172	4.10E-04	376938	4.20E-04	0	0.00E+00	333108	3.71E-04	113958	1.27E-04	113958	1.27E-04
13	11.000 - 12.000	11.5	324342	4.74E-04	333108	4.87E-04	0	0.00E+00	271746	3.97E-04	113958	1.67E-04	26298	3.85E-05
14	12.000 - 13.000	12.5	262980	4.94E-04	271746	5.10E-04	0	0.00E+00	175320	3.29E-04	17532	3.29E-05	26298	4.94E-05
15	13.000 - 14.000	13.5	315576	7.47E-04	219150	5.18E-04	0	0.00E+00	96426	2.28E-04	8766	2.07E-05	8766	2.07E-05
16	14.000 - 15.000	14.5	87660	2.57E-04	140256	4.11E-04	0	0.00E+00	70128	2.06E-04	26298	7.71E-05	0	0.00E+00
17	15.000 - 16.000	15.5	105192	3.77E-04	87660	3.14E-04	0	0.00E+00	78894	2.82E-04	17532	6.28E-05	0	0.00E+00
18	16.000 - 17.000	16.5	78894	3.41E-04	87660	3.79E-04	0	0.00E+00	35064	1.51E-04	8766	3.79E-05	0	0.00E+00
19	17.000 - 18.000	17.5	61362	3.16E-04	61362	3.16E-04	0	0.00E+00	17532	9.03E-05	8766	4.52E-05	0	0.00E+00
20	18.000 - 19.000	18.5	43830	2.67E-04	8766	5.34E-05	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
21	19.000 - 20.000	19.5	17532	1.25E-04	8766	6.25E-05	0	0.00E+00	17532	1.25E-04	8766	6.25E-05	0	0.00E+00
22	20.000 - 21.000	20.5	8766	7.26E-05	17532	1.45E-04	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
23	21.000 - 22.000	21.5	17532	1.68E-04	0	0.00E+00	0	0.00E+00	0	0.00E+00	8766	8.38E-05	0	0.00E+00
24	22.000 - 23.000	22.5	0	0.00E+00	17532	1.92E-04	0	0.00E+00	17532	1.92E-04	0	0.00E+00	0	0.00E+00
25	23.000 - 24.000	23.5	8766	1.09E-04	8766	1.09E-04	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
26	24.000 - 25.000	24.5	8766	1.24E-04	8766	1.24E-04	0	0.00E+00	17532	2.48E-04	0	0.00E+00	0	0.00E+00
27	25.000 - 26.000	25.5	17532	2.80E-04	8766	1.40E-04	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
28	26.000 - 27.000	26.5	0	0.00E+00	8766	1.57E-04	0	0.00E+00	8766	1.57E-04	0	0.00E+00	0	0.00E+00
29	27.000 - 28.000	27.5	0	0.00E+00	8766	1.75E-04	0	0.00E+00	8766	1.75E-04	0	0.00E+00	0	0.00E+00
30	28.000 - 29.000	28.5	8766	1.95E-04	8766	1.95E-04	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
31	29.000 - 30.000	29.5	8766	2.16E-04	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
32	30.000 - 31.000	30.5	8766	2.39E-04	8766	2.39E-04	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
33	31.000 - 32.000	31.5	0	0.00E+00	8766	2.63E-04	0	0.00E+00	17532	5.27E-04	0	0.00E+00	0	0.00E+00
34	32.000 - 33.000	32.5	8766	2.89E-04	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
35	33.000 - 34.000	33.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
36	34.000 - 35.000	34.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
37	35.000 - 36.000	35.5	26298	1.13E-03	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
38	36.000 - 37.000	36.5	43830	2.05E-03	17532	8.20E-04	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
39	37.000 - 38.000	37.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	8766	4.44E-04	0	0.00E+00	0	0.00E+00
40	38.000 - 39.000	38.5	0	0.00E+00	8766	4.81E-04	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
41	39.000 - 40.000	39.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	8766	5.19E-04	0	0.00E+00	0	0.00E+00
42	40.000 - 41.000	40.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
43	41.000 - 42.000	41.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	8766	6.02E-04	0	0.00E+00	0	0.00E+00
44	42.000 - 43.000	42.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
45	43.000 - 44.000	43.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
46	44.000 - 45.000	44.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
47	45.000 - 46.000	45.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
48	46.000 - 47.000	46.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
49	47.000 - 48.000	47.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
50	48.000 - 49.000	48.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
51	49.000 - 50.000	49.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
52	50.000 - 51.000	50.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	8766	1.09E-03	0	0.00E+00
53	51.000 - 52.000	51.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
54	52.000 - 53.000	52.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
55	53.000 - 54.000	53.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
56	54.000 - 55.000	54.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
57	55.000 - 56.000	55.5	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
58	56.000 -		0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00	0	0.00E+00
Totals			5750496	9.65E-03	5794326	7.55E-03	7416036	6.49E-05	5662836	6.15E-03	6688458	2.83E-03	17558298	8.18E-04
Fatigue Life (years)				103.6		132.5		15405.6		162.7		352.9		1222.6

APPENDIX C

DATABASE USER MANUAL

SCR DATABASE MANUAL (DRAFT)

INTEC Engineering has prepared a database of steel catenary risers (SCR's) throughout the world with data from Offshore Technical Conference (OTC) papers and information from Minerals Management Service (MMS). In this program SCR's are found by querying the operator, riser diameter, or water depth and by flipping through the entered forms. The database is maintained by entering information for new projects with SCR's.

Upon opening the program, the main switchboard opens and allows you access to Pipeline Operator and Project Name, SCR Input Data Input Form, Database Query Form, Operator/Project Report, Short SCR Report, and Detail SCR Report tabs.

PIPIELINE OPERATOR AND PROJECT NAME

Under this tab all projects and operators are listed, and text can be entered and edited. For a project with lots of SCR's, it would save time to enter its name here instead of entering it repeatedly in the SCR Data Input Form.

SCR DATA INPUT FORM

The input forms have all the information that can be queried or seen in the reports. For a new form, click the Add New Form button in the Utilities box on the right side of the screen. You can arrange the records from ascending to descending (or vice versa) by right clicking on any of the fields and selecting Sort Ascending (A → Z) or Sort Descending (Z → A).

Pipeline owner drop-down menu. You can also enter the name of the owner manually. Anytime you click on the operator box, you'll be asked if you want to change the name.

Project. The project name is entered manually if you can't find it on the pipeline owner drop-down menu.

The next few windows ask for self-explanatory project parts like platform type, offshore block, location(Gulf of Mexico, Brazil, Nigeria, etc.), SCR description (OD and gas or oil export), top connection (flexjoint, stress joint, clamps, etc.), designer, vortex induced vibration (VIV) suppression, status (existing, future, or near completion), and other/existing or future risers.

An additional note on the SCR description—you can say here that it's a pipe in pipe (PIP). They're listed as inner pipe diameter x outer pipe diameter. This information can otherwise be entered in the PIP box.

The comments, SCR history, and notes boxes are in the lower right corner of the data sheet. In the notes section, credit is given to the source from where the SCR information came.

The following fields on the Data Input Form can be checked as proprietary, so confidential information can't be accessed through the Non-Proprietary database which is generated from this main database: diameter, depth, and departure angle of the SCR, number of risers, design life, first production year, pressure, temperature, wall thickness of the pipe, steel grade, production rates (mbod for oil, mmscfd for gas), service (sweet or sour), pipe type, instruments/description, if there's insulation and what kind, PIP data, bulkhead design, clad, CP system, pipe coatings, how installed (S-lay, J-lay, reeled), year installed, the date of the data the information came from, pipeline segment #, ROW number, in or out of service, and current monitoring.

DATABASE QUERY FORM

You can search for projects with a given SCR diameter, water depth, or operator. When it comes to diameter and depth, you can search for values equal to, less than, or greater than what you enter.

Results can be in either short or long report form. Short reports contain the operator, project, number of risers, riser diameter, depth, description, block, location, platform type, steel grade, wall thickness, and top connection. Long report shows everything that can be entered into one of the Database Input Forms.

On the right side of the Database Query Form there is a transfer database macro generation button. Once activated, this completes the process of transferring non-proprietary information to the Non- Proprietary database. The process of transferring data requires that the Non-Proprietary database file be located on C:\MMS Database\MMS SCR Database - No Proprietary 2000.mdb. The prescribe file location can be changed but does require the modification of the Transfer Data Q query. Should you encounter any problems with or wish to change this transfer process, please call Scott Reeves at 281.925.2393 or 832.244.4667 (after regular business hours).

OPERATOR / PROJECT REPORT

This tab shows a list of all the projects and their respective operators.

SHORT SCR REPORT (ALL SCR'S)

This tab gives information on all SCR's in spreadsheet format, listing the operator, project, number of risers, riser diameter, depth, description, block, location, platform type, steel grade, wall thickness, and top connection of all the projects.

DETAIL SCR REPORT (ALL SCR'S)

This tab gives all available information on every SCR, showing all the information that could be entered in the SCR Database Input Form.